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STIMULATING TECHNICAL INNOVATION BY SMALL AND MEDIUM-SIZED
ENTERPRISES IN CHINA

BY

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DISSERTATION

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ABSTRACT

The effect of innovation on the economy is increasingly obvious and important in many countries, including China. In order to encourage and sustain technological innovation, Small and Medium sized Enterprises (SMEs) are not only necessary but also vital. This dissertation presents an empirical study to test what critical measures the government should adopt and balance in order to efficiently pursue its goal of increasing innovation by SMEs.

This dissertation focuses on the measures of intellectual property (IP), public sector, including the subsidies or grants from the government, as well as the private sector, indicating the financial tools as the main capital resources for technology companies. The government makes the rules and policies for both a market-oriented economy and a government-oriented economy. However, under both models, the government should craft meaningful rules and regulations that benefit SMEs. Accordingly, government regulators need to know whether they should encourage the free market further or pursue command and control in the government-dominated sector. This study will evaluate the flexibility of the different administrative systems, rules and regulations of IP, taxes, subsidies, financial markets, and other related government actions.

This study will use panel data regressions to access the 140 public SMEs from two science parks in China, Zhongguan-Cun Science Park in Beijing and Zhangjiang Hi-Tech Park in Shanghai. Its goal is to learn the efficiency of the variance of the rules and policies in their innovation between 2009 and 2013, especially when the rules and policies are criticized by other countries as a weak IP regime, over subsidies, weak lender protection and bad enforcement of financial contract. Moreover, this study will also use difference-in-difference estimations to study the impact of the 2011 tax policy changes in China and the 2012 patent subsidy policy change in Shanghai on the innovation, market performance and patenting behaviors of the 140 SMEs.

Zhongguan-Cun Science Park and Zhangjiang Hi-Tech Park are two national model

technical industry parks, and they include most of the enterprises that develop technologies in Beijing or Shanghai. Usually, various types of national favoring policies apply to the firms in these two science parks ahead of the science parks in the other provinces in China. Their administrative measures are tested and analyzed, and the most successful and innovative measures are then applied to other science parks.

Regardless of the effective measures that had caused the successful growth of the domestic companies, the Chinese government has continued to provide funding, offering subsidies and attractive regulations for them. The main objective of the policies in the two parks is to create and to facilitate technical SMEs' survival and growth. The government also understands the important of the capital from the financial market, so it is providing guide funds and policies governing the financial market. In addition, the government is also guiding companies to use IP regimes to improve their ability to compete and the government expects original innovations from them to improve China's ability to compete and innovate in the technology sector in a time of globalization. However, the costs of different measures are different, so it is necessary for the government to identify the most efficient strategies to encourage SMEs' creation. Hence, besides independently testing the efficiency of each approach of the policies, this study combines and compares the efficiency of the three approaches of policies in stimulating the SME to innovate.

The results from this work will not only help the government of China to understand the strategies adopted by the two cities for stimulating technical innovation by SMEs, but it will also help to engineer similar science parks in the other provinces. In addition, this work will help other developing countries to learn effective strategies involving policies, laws and regulations to create SMEs, and to simultaneously develop technological innovation and the economies of their countries.

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their work experience. In the process of developing my research, my father acted as my instructor and my mother acted as my assistant. With my their instruction and assistance, I can correctly locate the critical policies for supporting SMEs and capture the critical business information of the SMEs in an early stage of the research.

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CHAPTER ONE INTRODUCTION

Small and medium-sized enterprises (SMEs) play a critical role in the development of the economy.¹ As “the engine of an economy,” SMEs are responsible for a large part of exports and imports of goods in many countries. Also, “they are an essential source of jobs, create entrepreneurial spirit and innovation and are thus crucial for fostering competitiveness and employment.”²

Over the past 30-40 years, many western governments have identified startups and SMEs as significant components in economic strategies to create employment, increase productivity and commercialize innovations.³ Among all the industries in the U.S. in 1982, SMEs accounted for 94.2% of all firms, 21.4% of sales, and 28.9% of employment in manufacturing.⁴ Simultaneously, about 60% of the positions of employment in the areas involving cutting-edge technology are created by SMEs in Japan,⁵ and SMEs provide 80% positions of employment in China.⁶ In a global scale, SMEs on average account for approximately 60% of manufacturing employment.⁷

The degree of the importance of SMEs on economy, however, depends on their growth

¹ Stephane Rousseau, “The Future of Capital Formation for Small and Medium-Sized Enterprises: Rethinking Initial Public

² The European Commission, *User Guide to the SME Definition*, 2003, 35, accessed June 21, 2016, http://ec.europa.eu/growth/index_en.htm.

³ Sue Birley and Paul Westhead, “Growth and Performance Contrasts Between ‘types’ of Small Firms,” *Strategic Management Journal* 11 (1990): 535. Also see, Stephen Barkoczy and Peter Edmundson, “Australasian and South East Asian Venture Capital Tax Expenditure Programs,” *Intertax* 37, no. 1 (2009): 56.

⁴ Charles P. Himmelberg and Bruce C. Petersen, “R&D and Internal Finance: A Panel Study of Small Firms in High-Tech Industries,” *The Review of Economics and Statistics* 76, no. 1 (1994): 49.

⁵ Eric C. Sibbitt, “Law, Venture Capital, and Entrepreneurism in Japan: A Microeconomic Perspective on the Impact of Law on the Generation and Financing of Venture Businesses,” *Conn. J. Int’l L.* 13 (n.d.): 61.

⁶ Xiulin Pan (潘秀林) and Gu Yu (谷裕), “Shangwubu Buzhang Zhuli: Zhongguo Zhongxiaoqiye Tigong 80% Jiuye Jihui (商务部部长助理：中国中小企业提供 80% 就业机会) [The Minister Assistance of He P.R.C. Ministry of Commerce: China’s SMEs Provide 80% Employment Opportunities],” *Wangyi Caijing* (网易财经) [Wangyi Finance], 2010, accessed June 21, 2016, <http://money.163.com/10/0701/11/6AGLACJ000254IH0.html>.

⁷ Thorsten Beck, Asli D. Kunt, and Maria Soledad Martinez Peria, *Bank Financing for SMEs around the World: Drivers, Obstacles, Business Models, and Lending Practices*, *World Bank Policy Research Working Paper Series*, 2008, accessed June 21, 2016, <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Bank+Financing+for+SMEs+around+the+World#2.1>.

capabilities.⁸ Despite a high proportion that SMEs account for firms in the market, the failure rate of SMEs is also very high. “95% of new businesses fail within the first five years.”⁹ In the past 5-10 years, the failure rate of startups was around 80% in the U.S., 42% in Australia and 50% in the U.K.¹⁰ In the context of China, the average life length of an SME is only 2.5 years.¹¹ In order to develop and survive, SMEs need to innovate to improve their competitiveness through developing new or improved technologies.¹² A survey in Belgium has revealed that research and development (R&D) support can increase sales to roughly 19%.¹³

On the other side, R&D spending by its own is significant to the development of the economy.¹⁴ In the U.S., R&D spending is between \$300 billion and \$400 billion per year and accounts for roughly 2.7% of GDP.¹⁵ Even though R&D spending usually is concentrated in developed countries,¹⁶ there is empirical evidence suggesting a positive correlation between GDP per capita and R&D in both OECD and non-OECD countries.¹⁷

In order to encourage and sustain innovation and its pivotal role in national growth, SMEs are not only necessary but also vital. SMEs' business structure has highly flexible and intensive human dimensions in both the horizontal and the vertical branches, which create strong interconnection through the formal and informal elements and intensive decisional centralization

⁸ Rousseau, “The Future of Capital Formation for Small and Medium-Sized Enterprises: Rethinking Initial Public Offering Regulation after the Restructuring of Canadian,” 665.

⁹ Moya K. Mason, “What Causes Small Business to Fail?,” 2009.

¹⁰ Mark Pizzacalla, “SME ‘Life Cycle’ Imperative,” *Austl. Tax F.* 27 (2012): 195.

¹¹ Yang Fu (傅洋), “Diaocha Xianshi Zhongguo Zhongxiao Qiye Pingjun Shouming Jin 2.5 Nian(调查显示中国中小企业平均寿命仅 2.5 年)[Survey Shows That the Life Length of SMEs in China on Average Is Only 2.6 Year],” *Beijing Wanbao*(北京晚报)[*Beijing Evening Paper*], 2012, accessed June 21, 2016, <http://finance.people.com.cn/n/2012/0903/c70846-18906006.html>.

¹² U.S. Department of Commerce, *The Competitiveness and Innovative Capacity of the United States*, 2012, accessed June 21, 2016, <http://www.esa.doc.gov/sites/default/files/thecompetitivenessandinnovativecapacityoftheunitedstates.pdf>.

¹³ Bart Clarysse, Valentijn Bilsen, and Geert Steurs, “Behavioural Additionality of the R&D Subsidies Programme of IWT-Flanders (Belgium),” in *Government R&D Funding and Company Behaviour: Measuring Behavioural Additionality*, 2006, 92–114.

¹⁴ Andrew Metrick and Ayako Yasuda, *Venture Capital & the Finance of Innovation*, 2nd editio (John Wiley & Sons, Inc., 2011), 339.

¹⁵ Ibid.

¹⁶ Ibid.

¹⁷ Hulya Ulku, *R&D, Innovation, and Economic Growth: An Empirical Analysis*, 2004, accessed June 21, 2016, <https://www.imf.org/external/pubs/ft/wp/2004/wp04185.pdf>, 27.

so that innovations could be realized effectively and efficiently.¹⁸

The World Bank's data show that the SMEs in the U.S. have continually increased their share of total industrial R&D during the last two decades. The same trend also appears to be occurring in China. For example, the data from the P.R.C. Industrial and Commercial Bureau suggest that in 2007, the China's SMEs accounted for 65% of patent filings and 80% of new product development. However, while China is gradually transforming from an imitation-oriented country to an innovation-oriented country,¹⁹ innovation by SMEs is still relatively scant.

One situation is that most of the SMEs in China are in the fields of processing and manufacturing, where few opportunities for innovation exist. Those process industries can bring many employment positions, but they cannot provide much of China's innovative energy. Also, because labor costs there have surged up 20% a year in the past four to eight years in China,²⁰ some global companies are moving their processing plants to other countries. Therefore, the Chinese government is trying to shift the role of SMEs in its economy from the engine of manufacturing to the engine of technology.

Moreover, most of the large enterprises in China are in the field of energy, real estate and finance, which are owned by the government. Most of the time, they are monopolies and control a vital segment of social resources; their impact on the economy is large because they have ultimate control of the resources due to their size and special relationship with the national, provincial, and local governments. Under this situation, these large monopolies do not have much incentive to innovate. Also, because their systems are huge and rigid, it is difficult for them to be flexible and efficient to conduct technical innovation. They do, however, act as venture capitalists for SMEs or buy patent licenses from them. Accordingly, China is a

¹⁸ Ovidiu Nicolescu, "Main Features of SMEs Organisation System," *Review of International Comparative Management* 10, no. 3 (2009): 405, accessed June 21, 2016, http://rmci.ase.ro/ro/no10vol3/Vol10_No3_Article1.pdf.

¹⁹ Yahong Li, "Intellectual Property and Innovation: A Case Study of High-Tech Industries in China," *Or. Rev. Int'l L.* 13 (2011): 265.

²⁰ Shaun Rein, "The End of Cheap China," *The Economist*, 2012, accessed June 21, 2016, <http://www.economist.com/node/21549956>.

prominent example of a developing country to be studied with about innovation by SMEs.

With respect to the demands of innovation by SMEs for the development of the economy, in 2014, the Chinese Premier Li Keqiang proposed “mass entrepreneurship and innovation,” which was authorized by the P.R.C. State Council to promote entrepreneurship and innovation by any people and in any industries in that following year.²¹ In other countries, the governments also have adopted various policies to support the survival and innovation of SMEs. The U.S. government, for example, established the Small Business Association (SBA) in 1953.²² Germany also has similar programs to facilitate the growth of SMEs and their innovations, such as the European Recovery Program (ERP), which was started in 1947, and Equity Stock Companies (Kapitalbeteiligungsgesellschaften), which were initiated in the 1950s and 1960s.²³

In a long history, since SMEs have a significant impact on economy, and the growth and innovation of SMEs bolster the growth of the economy, it is meaningful to study how SMEs are stimulated to innovate. There are usually three key measures—government supports, intellectual property (IP), and financing. This dissertation follows the three tracks to study the critical and complementary measures discussed above in the context of China.

Chapter 2 explains the impact of government supports on the innovations by SMEs. SMEs face to various types of business risks, such as the economy environment, the industry entrance, and other unique risks, so as to be difficult to survive on its own.²⁴ In order to induce them to innovate and finally succeed to survive, the government subsidizes them and their innovations.²⁵ The most critical subsidy is through tax credits that are directly provided to SMEs or some external connections regarding their financing or market.

²¹ Zhonghua Renmin Gonghe Guo Guowu Yuan(中华人民共和国国务院)[The State Council of the P.R.C.], *Guowuyuan Guanyu Dali Tuijin Dazhong Chuangye Wanzhong Chuangxin Ruogan Zhengce Cuoshi De Yijian*[国务院大力推荐大众创业万众创新若干政策的意见](The Opinions of the State Council on Several Policies about Strongly Recommending Mass Entrepreneurship and Innovation), 2015.

²² Mark Pizzacalla, “Global SME Tax Policy Conundrum,” *Austl. Tax F.* 23 (2008): 54, http://heionlinebackup.com/hol/cgi-bin/get_pdf.cgi?handle=hein.journals/austraxrum23§ion=7.

²³ Leslie a. Jeng and Philippe C. Wells, “The Determinants of Venture Capital Funding: Evidence across Countries,” *Journal of Corporate Finance* 6, no. 3 (September 2000): 282.

²⁴ Pizzacalla, “SME ‘Life Cycle’ Imperative,” 191.

²⁵ Edmund W. Kitch, “The Nature and Function of the Patent System,” *Journal of Law and Economics* 20 (1977): 288.

The SMEs in different stages of development could be affected by tax credits to different degrees.²⁶ For some SMEs, tax incentives may not be effective enough to improve their R&D, especially under the globalization when multiple governments provide various categories of tax credits at different levels to attract and promote innovation.²⁷

Moreover, funding is another critical measure broadly undertaken by the government to stimulate innovation by SMEs and improve their R&D capabilities and R&D commercialization as functional as sales do.²⁸ However, while R&D funding has similar effects to promote innovation by SMEs as tax credits do, or R&D funding even has stronger effects than the tax credits, as a result of the low possibility of their survival and spillovers of technology,²⁹ it is still a hazard how effective this measure is.³⁰ For example, the EU government believes that government funding is a necessary condition to induce SMEs to conduct innovation and significantly improves their R&D capabilities.³¹ Meanwhile, it is inevitable that information asymmetry issues result in the failures of government funding to SMEs.³² Therefore, the efficiency of various categories should be measured case-by-case. For the ambitions of the Chinese government, the possibilities of the SMEs in its market and their gap with the innovative SMEs in developed countries, Chapter 2 analyzes the various types of government supports, including grants, tax credits, prizes and other subsidies. It then combines the theories in the context of China with empirical evidence.

The government also designs IP regimes as a kind of instrumental regulation to promote

²⁶ Pizzacalla, "SME 'Life Cycle' Imperative," 176.

²⁷ Kenneth M Brown, "The Elusive Carrot : Tax Incentives for R & D," *Regulation* 8, no. 1 (1984): 33–38.

²⁸ Jari Hyvarinen, "Behavioural Additionality of Public R&D Funding in Finland," in *Government R&D Funding and Company Behaviour: Measuring Behavioural Additionality*, 2006, 115–26.

²⁹ Bo Zhao and Rosemarie Ziedonis, *State Governments as Financiers of Technology Startups: Implications for Firm Performance*, 2012, accessed June 21, 2016, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2060739.

³⁰ Rahel Falk, "Behavioural Additionality of Austria's Industrial Research Promotion Fund (FFF)," in *Government R&D Funding and Company Behaviour: Measuring Behavioural Additionality* (Paris: OECD, 2006), 59–74, accessed June 21, 2016, http://www.wipo.int/pressroom/en/articles/2014/article_0018.html.

³¹ Wolfgang Polt and Foteini Psarra, "Behavioural Additionality of the EU's 5th Framework Programme," in *Government R&D Funding and Company Behaviour: Measuring Behavioural Additionality*, 2006, 235–46.

³² Scott J. Wallsten, "The R&D Boondoggle," *Regulation* 23, no. 4 (2000): 12–16.

innovation,³³ but the importance and the efficiency of the formal protection by patents for technologies is also controversial.³⁴ Therefore, Chapter 3 studies the efficiency of IP regimes on stimulating innovation by SMEs.

In the recent years, the patent applications in China have dramatically grown and China even drives the global patent application growth.³⁵ Based on the statistics by the World Intellectual Property Organization (WIPO) in 2013, the filed patent applications in China accounted for a third of the world's 2.6 million patent applications, and China has become the third largest country with patent application filings, ranking after the U.S. and Japan. Over 84 percent of the local patent applications in China were filed by firms and particularly in some cities, and the statistics by the Industrial and Commercial Bureau of China show that over 60 percent of the patent applications were filed by SMEs.³⁶

Nevertheless, patents are not exactly equal to innovation and also incapable to completely represent the outcomes of R&D.³⁷ Patenting propensity varies among firms,³⁸ and it may also not be relevant to the increase of the strength of IP protection.³⁹ A survey by Acs and Audretsch shows that in different technological and economic environments, the considerations of small and large firms to utilize patents to protect invention outcomes are different.⁴⁰ According to the complexity of the theories and practice on how IPRs provide innovation incentives to SMEs,

³³ Daniel Gervais, "Of Clusters and Assumptions: Innovation as Part of a Full TRIPS Implementation," *Fordham Law Review* 77, no. 5 (2009): 2377.

³⁴ Brownyn Hall et al., "The Choice between Formal and Informal Intellectual Property: A Review," *Journal of Economic Literature* 52, no. 2 (2014): 376, accessed June 21, 2016, http://128.32.105.3/~bhall/papers/HHRS13_IP_choice_lit_survey.pdf.

³⁵ World Intellectual Property Organization (WIPO), *Global Intellectual Property Filings Up in 2013, China Drives Patent Application Growth*, 2014.

³⁶ Jianguo Zhao (赵建国), "Gongxinbu Guozhiju: Zhongxiao Qiye Zhishi Chanquan Zhanlue Tuijin Gongcheng Xian Chengxiao(工信部、国知局: 中小企业知识产权战略推进工程显成效)[The Industrial and Commercial Bureau and SIPO: The Project of Promoting SMEs' IP Strategies Shows Achievements]," *Guojia Zhishi Chanquan Bao(国家知识产权报)[China Report Intellectual Property]*, 2014, accessed June 21, 2016, <http://www.nipso.cn/onews.asp?id=22189>.

³⁷ Zoltan J. Acs and David B. Audretsch, "Innovation in Large and Small Firms: An Empirical Analysis," *The American Economic Review* 78, no. 4 (1988): 688.

³⁸ Hall et al., "The Choice between Formal and Informal Intellectual Property: A Review," 394.

³⁹ Samuel Kortum and Josh Lerner, "Stronger Protection or Technological Revolution: What Is Behind the Recent Surge in Patenting?," in *Carnegie-Rochester Conference*, 1997.

⁴⁰ Acs and Audretsch, "Innovation in Large and Small Firms: An Empirical Analysis," 688.

Chapter 3 uses empirical methods to analyze the IP regime in China for promoting innovation by SMEs.

Besides government supports, the measures to finance R&D includes the internal financing by the profits as well as the external financing by bank loans, public equity market, venture capital (VC), and enterprise investors as alliances.⁴¹ Chapter 4 discusses how external financing impacts innovation by SMEs.

The efficiency of the financial sector is significant to economic growth.⁴² In particular, venture capital has positive effects on creating jobs and promoting innovation.⁴³ VC has successfully become the next rescuersalvation of the development of the economy after manufacturing and cheap labors.⁴⁴ Data for the 1980s and the 1990s in the U.S. shows that 36.3 percent of investments in the early-stage of SMEs were made by venture capitalists.⁴⁵

In developing countries, the requirements of public equity are too high to be satisfied by SMEs, so venture capital and private equity becomes popular.⁴⁶ Statistics show that the VC market in developing countries is continuously growing and expanding, and follows the success of the VC market in the U.S.⁴⁷ Beyond the capital contribution provided by the VCs, they also provide non-cash contributions, such as business management.⁴⁸

By contrast, debt financing may not be appropriate for innovative SMEs.⁴⁹ Even though

⁴¹ Metrick and Yasuda, *Venture Capital & the Finance of Innovation*, 349.

⁴² Alison Harwood, "Financing Reform in Developing Countries," in *Sequencing? Financial Strategies for Developing Countries*, ed. Alison Harwood and Bruce L.R. Smith (Brookings Institution Press, 1997), 70.

⁴³ Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries," 242.

⁴⁴ Ronald J. Gilson, "Engineering a Venture Capital Market: Lessons from the American Experience," *Stanford Law Review* 55, no. November (2003): 1124, accessed June 21, 2016, http://www.researchgate.net/publication/5197504_Further_Evidence_that_Legalized_Abortion_Lowered_Crime_A_Reply_to_Joyce/file/32bfe50e325f772809.pdf.

⁴⁵ Paul Gompers et al., *Venture Capital Investment Cycle: The The Impact of Public Market*, NBER Working Paper Series, n.d, 9.

⁴⁶ Josh Lerner, Felda Hardyman, and Ann Leamon, *Venture Capital and Private Equity: A Case Book*, fifth edit (John Wiley & Sons, Inc., 2012), 247-248.

⁴⁷ Ibid, 243.

⁴⁸ Gilson, "Engineering a Venture Capital Market: Lessons from the American Experience," 1075. Also see, Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries," 247.

⁴⁹ P Winker, "Causes and Effects of Financing Constraints at the Firm Level," *Small Business Economics* 12, no. 2 (1999): 170.

the cost of equity financing is high for SMEs and entrepreneurs may be anxious about venture capitalists (VCs) who they are not familiar with, they may firstly try debt financing before equity financing,⁵⁰ even if the cost of debt financing is not necessary lower than equity financing.⁵¹ The interest for loans is dead lost for the debtors, and the increase of the interest negatively affects the business of the SME debtors.⁵²

On the other hand, since R&D is risky, it is hardly to predict its output when the investors invest in R&D projects.⁵³ Investors usually do not invest in riskier investments when they evaluate their target firms.⁵⁴ Meanwhile, some policymakers believe that it is safe to control the capital within various industries to develop economy, compared to the other types of market controls.⁵⁵ Hence, all the external financing resources could be essential to SMEs and their innovation.

In the face of globalization, U.S. investors have started investing more heavily in China's technology market.⁵⁶ For example, Intel Capital recently invested \$67 million in eight Chinese startups, and Dell Inc. pledged \$125 billion of investments towards Chinese businesses, including technological components purchasing and manufacturing expenses.⁵⁷ Corresponding to the entrance of foreign VCs, China can become a successful example of the development of the VC market in developing countries.⁵⁸

⁵⁰ Elisabeth Mueller and Frank Reize, *Loan Availability and Investment: Can Innovative Companies Better Cope with Loan Denials?*, ZEW (Centre for European Economic Research), 2010, 5, accessed June 21, 2016, <http://www.tandfonline.com/doi/abs/10.1080/00036846.2013.808314>.

⁵¹ Bronwyn H. Hall, *Investment and Research and Development at the Firm Level: Does the Source of Financing Matter*, WORKING PAPER, 1992, 10.

⁵² Winker, "Causes and Effects of Financing Constraints at the Firm Level," 170.

⁵³ Kenneth J. Arrow, "Economic Welfare and the Allocation of Resources for Invention," *The Rate and Direction of Inventive Activity: Economic and Social Factors I* (1962): 609–26.

⁵⁴ Sibbitt, "Law, Venture Capital, and Entrepreneurism in Japan: A Microeconomic Perspective on the Impact of Law on the Generation and Financing of Venture Businesses," 85.

⁵⁵ Curtis J. Milhaupt, "The Small Firm Financing Problem: Private Information and Public Policy," *J. Small & Emerging Bus. L.* 2 (1998): 185.

⁵⁶ Runhua Wang, "Utility Models Revisited: The Case of Investing in China," *Elect. U.I.L.L. J. L. Tech. & Pol'y*, 2015, accessed June 21, 2016, <http://illinoisjltp.com/timelytech/utility-models-revisited-the-case-of-investing-in-china/>.

⁵⁷ Eva Dou, "Intel Capital Invests \$67 Million in Eight Chinese Startups," *The Wall Street Journal*, 2015, accessed June 21, 2016, <http://www.wsj.com/articles/intel-capital-invests-67-million-in-eight-chinese-startups-1442492847>.

⁵⁸ Lerner, Hardyman, and Leamon, *Venture Capital and Private Equity: A Case Book*, 253.

As a developing country, China has a VC market that inevitably involves government direct funding, subsidies, state-owned VCs and state-owned enterprise investors. Chapter 4 employs empirical methods to study the public SMEs in China and the association between their behaviors with respect to external financing and innovation, both of which essential conditions and significant outcomes for each other. Due to information asymmetries that are serious among high-tech SMEs,⁵⁹ investors and debtors value the IPRs, the intangible assets, owned by the portfolio SMEs.⁶⁰ Therefore, beyond the discussion of the association between innovation and external financing by SMEs, Chapter 4 also considers the effects of IPRs in the financing process.

⁵⁹ Himmelberg and Petersen, "R&D and Internai Finance: A Panel Study of Small Firms in High-Tech Industries," 39.

⁶⁰ Rainer Haselmann and Paul Wachtel, "Institutions and Bank Behavior," in *CEPR/EBRD Tokyo Conference*, accessed January 16, 2015, http://web-docs.stern.nyu.edu/old_web/emplibrary/ACFCwCg70.pdf. Also see, Mariassunta Giannetti, "Do Better Institutions Mitigate Agency Problems? Evidence from Corporate Finance Choices," *The Journal of Financial and Quantitative Analysis* 38, no. 1 (March 2003): 185–212.

CHAPTER TWO SUBSIDIES/GRANTS BY THE GOVERNMENTS & SMES' TECHNICAL INNOVATION

I. Literature Review - Government Involvements

In this part, the literature argues how various government supporting policies or restrictions directly or indirectly have effects on the R&D activities in SMEs. Most of the literature proves the effects through statistical data or cross-country empirical analysis. Section 1 discusses some basic types of subsidies, such as tax credits, and subsidies as awards, prizes or small amount of compensation for creating innovation incentives. These subsidies are ex post and take a relatively small share of their cost of R&D.

Comparatively, Section 2 presents how the government assists the investments in SMEs and their R&D projects and how their impressions are. The literature addresses that the government can directly fund the R&D in SMEs by grants, be their investors, or subsidize the financial markets to bridge SMEs and lenders or equity investors.

1. Government Subsidies for SMEs and Their R&D Activities

In the sense of administration, the government may protect SMEs' interest for their demands in the market when they are competing with large enterprises.⁶¹ Thus, scholars always have enthusiasm to study how the government can efficiently support SMEs and their R&D activities through funding, subsidies, awards, and subsidizing policies, and they also argue whether or not SMEs need these various types of subsidies.

This part firstly introduces the arguments on the effectiveness of tax credits by the

⁶¹ Lawrence Repeta, "The Small and Medium Enterprises Domain Protection Law of 1977: Its Operation and Likely Effect," *Law Japan* 10 (1977): 150.

government on encouraging R&D. Then, it presents how the scholars suggest that governments in various economies should adopt an appropriate prize or subsidy regime to encourage R&D.

1.1 Tax Credits

Many developed countries formulate tax policies as strategies to assist the survival and growth of SMEs.⁶² At a macro level, Pizzacalla believes that the Blair administration in the U.K. planned to build an SME friendly environment, so it removed tax barriers only for SMEs' growth.⁶³ Moreover, the U.S. federal tax reform in 1977 provided discriminated tax credits for different sizes of companies, although the recent tax reforms of the U.S. are more harmonized.⁶⁴ Pizzacalla argues that the discrimination in the tax policy is efficient; otherwise, the tax policy would not fill the "finance gap" of SMEs at their inception and survival stage.⁶⁵ Also, he believes that the tax credits for the SMEs in expansion stage are considerable for their R&D activities.⁶⁶ When Chinese governments are exploring specific policies to support SMEs doing technical innovations, Chen votes for tax reforms favoring SMEs because they are weak competitors in the market.⁶⁷

Pigou proposed to use taxes or subsidies to correct market failures and to improve the R&D incentives of innovators.⁶⁸ The economic logic is that the subsidies adding on to the private return of R&D increase their total return, which compensates the innovators in a higher level.⁶⁹ However, how efficient the tax incentives are on R&D is always a question. For example,

⁶² Pizzacalla, "Global SME Tax Policy Conundrum," 54.

⁶³ Ibid. 70-72, 78.

⁶⁴ Ibid. 71.

⁶⁵ Pizzacalla, "SME 'Life Cycle' Imperative," 201.

⁶⁶ Ibid. 204

⁶⁷ Jianlin Chen, "Challenges in Designing Public Procurement Linkages: A Case Study of SMEs Preference in China's Government Procurement," *UCLA Pac. Basin L. J.* 30 (2013): 157.

⁶⁸ Christine Greenhalgh and Mark Rogers, *Innovation, Intellectual Property, and Economic Growth* (Princeton University Press, 2010), 24.

⁶⁹ Bronwyn H Hall, "R&D Tax Policy during the 90s: Success or Failure?," in *Tax Policy and the Economy*, vol. 7 (MIT Press, 1993), 6.

Connor claims that tax provisions did not have a substantial influence on innovation in many companies.⁷⁰ In Canada, the survey about Ontario innovative healthcare firms in 2008, conducted by Cumming and Johan, shows that these firms have little concerns about the tax credits.⁷¹ The firms affected by the removal of tax credits are the firms that had previously received a relatively great amount of capital from the institutions providing the tax credits.⁷² Also, Brown suggests that the effects of tax incentives for R&D are merely procyclical.⁷³

Among the G5 countries, the U.S., Japan and France offer tax concessions to encourage R&D, but U.K. only provided these under size-discrimination (only to small firms) rather than for R&D demand until 2002, and Germany does not have a tax deduction mechanism with the both conditions.⁷⁴ The U.S. General Accounting Office reported that the research and experimentation tax credit created by Congress in 1981 stimulated between \$1 billion and \$2.5 billion additional R&D spending at a cost of \$7 billion in revenues foregone during the period of 1981 to 1985.⁷⁵ Also, Hall's empirical study proves that \$1 billion tax credits stimulated additional \$2 billion R&D expenditure per year during 1980s in the U.S.⁷⁶ Moreover, in 1970s, when South Korea's economy grew because of the increasing number of private companies, they adopted government tax incentives to encourage their companies to do R&D.⁷⁷

Currently, most of OECD countries (Organization for Economic Co-operation and Development) use tax credits to subsidize firms for increasing their business profits and creating

⁷⁰ U.S. Department of Commerce, *Technological Innovation: Its Environment and Management*, 1967, 31.

⁷¹ Douglas Cumming and Sofia Johan, "Phasing Out an Inefficient Venture Capital Tax Credit," *Journal of Industry, Competition and Trade* 10, no. November 2009 (2010): 249. The tax credits testified here are only the tax credits from the Labour Sponsored Venture Capital Corporations (LSVCC, also known as Labour Sponsored Investment Funds, or LSIFs), which have existed in the Province of Ontario since 1992, the primary mechanism for supporting entrepreneurial finance by Canadian government.

⁷² Ibid. 249. The organization is LSVCC.

⁷³ Brown, "The Elusive Carrot : Tax Incentives for R & D," 38.

⁷⁴ Greenhalgh and Rogers, *Innovation, Intellectual Property, and Economic Growth*, 25.

⁷⁵ U.S. General Accounting Office, *The Research Tax Credit Has Stimulated Some Additional Research Spending*, GAO/GGD-85-114, 1989, 30.

⁷⁶ Hall, "R&D Tax Policy during the 90s: Success or Failure?" 29.

⁷⁷ Greenhalgh and Rogers, *Innovation, Intellectual Property, and Economic Growth*, 106.

their R&D incentive, especially more on SMEs than large firms.⁷⁸ In Ernst & Young's study of OECD, the effects of tax incentives on R&D were positive in almost half of 23 countries over 2006 to 2011.⁷⁹ Hodzi's empirical study on the cases in Austria and Croatia concludes that their tax incentive systems efficiently encourage R&D.⁸⁰ Greenhalg, Rogers and Atkinson also believe that tax incentives are effective and significant policies in promoting innovation.⁸¹ For developing countries, Olwen suggests that they should have appropriate tax exceptions for local corporations to encourage them to provide free and open source software.⁸²

Hodzi, furthermore, emphasizes how political and economic system is important to the efficiency of the tax incentives for R&D.⁸³ Similarly, Hall reminds that tax policy is a short-term policy, so its effects are not isolated but related with the whole corporate tax system. Hence, it is necessary to learn the interaction of various types of tax credits for encouraging different incentives, such as SMEs, R&D or investment.⁸⁴

1.2. Subsidies, Prizes or Rewards

Fisher lists subsidies, and prizes or rewards as significant strategies of how governments encourage technical innovation.⁸⁵ Hall uses economic models to explain how subsidies correct

⁷⁸ OECD, *Tax Incentives for Research and Development : Trends and Issues*, 2002, 2-17.

⁷⁹ Ernst & Young, *OECD Issues New R&D Incentive Report*, 2014, accessed June 21, 2016, [http://www.ey.com/Publication/vwLUAssets/OECD_issues_new_R_and_D_incentive_report/\\$FILE/2014G_CM4345_OECD_issues_new_R_and_D_incentive_report.pdf](http://www.ey.com/Publication/vwLUAssets/OECD_issues_new_R_and_D_incentive_report/$FILE/2014G_CM4345_OECD_issues_new_R_and_D_incentive_report.pdf). 2.

⁸⁰ Sabina Hodži, "Tax Incentives for Research and Development in South Africa," *Economic Thgouth and Practice*, no. 2 (2013): 413.

⁸¹ Greenhalgh and Rogers, *Innovation, Intellectual Property, and Economic Growth*, 324. Also see Robert D. Atkinson, "Expanding the R&E Tax Credit to Drive Innovation, Competitiveness and Prosperity," *Journal of Technology Transfer* 32, no. April (2007): 617-28.

⁸² Rami M Olwan, *Intellectual Property and Development : Theory and Practice* (Springer Heidelberg New York Dordrecht London, 2011), 325, accessed June 21, 2016, <http://eprints.qut.edu.au/54839/>.

⁸³ Hodži, "Tax Incentives for Research and Development in South Africa," 413.

⁸⁴ Hall, "R&D Tax Policy during the 90s: Success or Failure?" 30.

⁸⁵ William Fisher, "Intellectual Property and Innovation: Theoretical, Empirical, and Historical Perspectives," in *New Essays in the Legal and Political Theory of Property*, ed. Stephen R. Munzer (Combrige University Press, 2001), 2.

market failure to increase R&D investment of investors.⁸⁶ Greenhalgh and Rogers point out that direct R&D subsidies and grants are important to provide firms incentives to innovate because of social benefits of the innovation and the limitation of social returns to their R&D from patents.⁸⁷ However, along with their understanding of the idea that the government can generally subsidize R&D, they also remind us the issue of information asymmetry, which causes the government impossible to fund specific invention.⁸⁸

In the face of globalization, Reichman, Rai, Newell and Wiener strongly recommend developing countries, which have relatively low market-driven inducement of innovation, to adopt a prize system to encourage original and initiative innovations.⁸⁹ Actually, Olwan's case study with Arab countries reports that indigenous people demand grants, subsidies, taxes, or screen quotas, without discrimination in category, to support the development of local communities.⁹⁰

Furthermore, Dosi and Stiglitz believe that a prize system can become an alternative to the patent system for providing R&D incentives, and its lower transaction cost makes it even much better than a patent system.⁹¹ Nevertheless, they still have a concern that the process of self-selection to prize by the government could disfavor smaller firms in reality.

In specific cases, Maskus and Okediji believe that public subsidies are important to induce new technologies, especially patentable innovations in broader alternative energy technologies.⁹²

⁸⁶ Hall, "R&D Tax Policy during the 90s: Success or Failure?" 6.

⁸⁷ Greenhalgh and Rogers, *Innovation, Intellectual Property, and Economic Growth*, 53-54, 88, 313. They also believe that it is necessary for the government to consider offer subsidies to business R&D when they are building the national innovation system.

⁸⁸ Ibid. 317.

⁸⁹ Jerome H. Reichman et al., "Intellectual Property and Alternatives: Strategies for Green Innovation," in *Intellectual Property Rights: Legal and Economic Challenges for Development*, ed. Mario Cimoli et al. (Oxford University Press, 2014), 373.

⁹⁰ Olwan, *Intellectual Property and Development: Theory and Practice*, 193.

⁹¹ Giovanni Dosi and Joseph E. Stiglitz, "The Role of IPRs in the Development Process, with Some Lessons from Developed Countries: An Introduction," in *Intellectual Property Rights: Legal and Economic Challenges for Development*, ed. Mario Cimoli et al. (Oxford University Press, 2014), 28-31.

⁹² Keith E. Maskus and Ruth L. Okediji, "Legal and Economic Perspectives on International Technology Transfer in Environmentally Sound Technologies," in *Intellectual Property Rights: Legal and Economic Challenges for Development*, ed. Mario Cimoli et al. (Oxford University Press, 2014), 394.

Comparatively, Burlamaqui and Cimoli treat subsidies as development rents, which a state needs credibility to withdraw when subsidized firms are underperformance, or as a permanent cost that infant industries could not mature will be added.⁹³

2. Government Direct Investment in SMEs: Grants and Funding

SMEs have difficulties acquiring capital from financial markets. This section uses literature to show how government agencies and institutions directly funded SMEs and their innovations, and Chapter 4 further discusses those difficulties in detail and how government agencies indirectly subsidize or fund SMEs and their innovations. To be clear, in this section, the scholars debate on the efficiency of the grants from the government or their direct investments in the firms on stimulating the R&D activities by the firms, especially by innovative SMEs.

Despite the fact that many countries setting programs to fund SMEs and their R&D activities, its effectiveness comparing to the engine of innovation from free market is always arguable among scholars. Reenen believes that while the pharmaceutical industry has stable demands from government funding, subsidies and regulations favoring R&D, the key of the success of the industry in the U.K. is the larger firms, which create a healthy labor markets to spread ideas.⁹⁴ Smith also points out that pharmaceutical is the industry with main sources of state funding in the U.K., but 49 percent of all R&D in this industry are funded by private firms over tens years.⁹⁵ Moreover, in the empirical study with the Canadian LSVCC, Cumming and Johan conclude that PE capital is more effective in encouraging R&D and patents that are obtained by innovative healthcare firms than LSVCC capital from government is.⁹⁶

The U.S. SBIR (small business innovation development) program mandated all federal

⁹³ Leonardo Burlamaqui and Mario Cimoli, "Industrial Policy and IPR: A Knowledge Governance Approach," in *Intellectual Property Rights: Legal and Economic Challenges for Development*, ed. Mario Cimoli et al. (Oxford University Press, 2014), 486.

⁹⁴ John Van Reenen, *Economics Issues for the U.K. Biotechnology Sector*, 2002, 11-12.

⁹⁵ Helen Lawton Smith, "Regulating Science and Technology: The Case of the UK Biotechnology Industry," *Law & Pol'y* 27 (2005): 200.

⁹⁶ Cumming and Johan, "Phasing Out an Inefficient Venture Capital Tax Credit," 250.

agencies to fund more than \$100 million on small businesses annually.⁹⁷ On the one hand, the statistic of SBA shows that there was a positive trend in external R&D spending when the funding was increasing from 1983 to 1997.⁹⁸ On the other hand, in this duration, while the empirical study conducted by Gompers and Lerner shows that the SBIR-subsidized firms enjoy greater employment and revenue, they conclude that the SBIR funding does not change how firms perform in their R&D activities.⁹⁹

Moreover, with regards to the result of a behavioral study, the OECD reports that direct R&D grants are becoming less important as a share of R&D in firms.¹⁰⁰ Comparatively, Wendland supports state aid rules are more likely in the form of regulations or plans, such as “the Lisbon Strategy for Growth and Jobs” by the EU commission, rather than in the form of subsidies or public funding to R&D.¹⁰¹ These state aid activities fund some intermediate institutions, such as TTIs (technology transfer institutes) funded by the Commission of E.U. because they do not influence the direction of the research, and they are aim to facilitate SMEs acquiring investment, risk capital and funding for R&D.¹⁰²

Greenhalgh and Rogers, however, take the examples of SMART program in the U.K. and Advanced Technology Program in the U.S. to argue that funding is still important to SMEs and R&D.¹⁰³ Precisely, because individual farmers have limited resources for carrying out systematic experimentation, Germany governments provided public funding of agriculture of research in the later 19th century, which was also imitated by the U.S., but Nuvolari and Tartari believe the success of this model is because public support involves policies and education, more

⁹⁷ Paul Gompers and Josh Lerner, *The Venture Capital Cycle*, 2nd ed. (MIT Press, 2004), 318.

⁹⁸ Ibid. 319.

⁹⁹ Ibid. 341.

¹⁰⁰ OECD, *Government R&D Funding and Company Behaviour. Mesuring Behavioural Additionality*, 2006, 232.

¹⁰¹ Bernhard Von Wendland, “R&D& I-State Aid Rules at the Crossroads-Taking Stock and Preparing the Revision,” *Eur. St. Aid L. Q.* 2012 (2012): 395.

¹⁰² Ibid. 407.

¹⁰³ Greenhalgh and Rogers, *Innovation, Intellectual Property, and Economic Growth*, 315.

than merely research.¹⁰⁴

By contrast, after Zhao and Ziedonis used empirical methods to study the state funding on R&D by entrepreneurial firms in Michigan, even though their study cannot prove that the state R&D funding or awards can induce the patenting activities by the firms, their research shows that the funding is an effective instrument in the survival of the start-ups.¹⁰⁵ Because of the imperfection of capital market, without the R&D funding or awards from the state, these start-ups are less likely to remain in business or acquire follow-on VC investment, especially when they cannot acquire funding or subsidies from the SBA.¹⁰⁶ Thus, Zhao and Ziedonis conclude the function of the funding or awards equals to the function of the first round VC investment.¹⁰⁷ They explain that while the state funding on R&D may not be effectively stimulate further R&D by the firms, the commercialization of the current R&D by the firms has been improved under this regime.¹⁰⁸

In the biotechnology industry, Allarakhia suggests the government and public funding agencies facilitating weaker innovators to enter research arenas.¹⁰⁹ When observing the practice of funding programs in the pharmaceutical industry, Coriat and Orsenigo believe that public funding to support private R&D is essential for developing the fundamental knowledge base and infrastructures to raise the industry and attract investment from the financial market.¹¹⁰

Moreover, because some public funding agencies expect more outputs of R&D putting in

¹⁰⁴ Alessandro Nuvolari and Valentina Tartari, "Innovation, Appropriability and Productivity Growth in Agriculture: A Broad Historical Viewpoint," in *Intellectual Property Rights: Legal and Economic Challenges for Development*, ed. Mario Cimoli et al. (Oxford University Press, 2014), 249.

¹⁰⁵ Their empirical study covers three state R&D funding programs, including the Michigan Life Science Corridor (MLSC), the Michigan Technology Tri-corridor (MTTC) and a new 21st Century Jobs Fund (21CJF) programs. Zhao and Ziedonis, *State Governments as Financiers of Technology Startups: Implications for Firm Performance*. 18.

¹⁰⁶ Ibid. 3, 20-22.

¹⁰⁷ Ibid. 20.

¹⁰⁸ Ibid. 25-27.

¹⁰⁹ Minna Allarakhia, "Mode of Entry for Emerging Markets: An Ex Ante and Ex Post Perspective of the Open Source Development and Management of Biotechnology Knowledge Assets," in *Intellectual Property Rights: Legal and Economic Challenges for Development*, ed. Mario Cimoli et al. (Oxford University Press, 2014), 349.

¹¹⁰ Benjamin Coriat and Luigi Orsenigo, "IPRs, Public Health and the Pharmaceutical Industry: Issues in the Post-2005 TRIPS Agenda," in *Intellectual Property Rights: Legal and Economic Challenges for Development*, ed. Mario Cimoli et al. (Oxford University Press, 2014), 222.

public domain, the choice between IP incentives and public funding is largely a trade-off for innovators. In this situation, Scotchmer concludes that public funding on R&D is extensive and efficient comparing to supporting R&D through an IP system.¹¹¹ Also, Olwan suggests the governments of Arab countries should adopt grants as a measure other than IP laws to support the development of their local communities.¹¹²

Meanwhile, however, when he points out that necessary funding is an important element of the success of creating the software industry in Jordan, he also reminds us that this success requires supporting industries and infrastructure with a supportive legal regime.¹¹³ Similarly, because of the lack of patent commercialization in China, Li suggests that Chinese government should improve the infrastructure for commercialization through funding, which is increasing, but is not enough yet.¹¹⁴

Another approach of thoughts to support government direct investment is similar to the thoughts of Gulinello, who believes that the government can establish a seed fund, just as the High Technology Venture Capital Fund that was created by Taiwanese government in 1950 and hold New Taiwan Dollar 800 million.¹¹⁵ The seed fund and other types of fund with government investment reduce monitoring costs for the private investors, so they can efficiently attract more private investors.¹¹⁶

3. Other Subsidized Policies Directly for Innovations

Previous sections discuss various types of monetary subsidies by the government

¹¹¹ S. Scotchmer, "The Political Economy of Intellectual Property Treaties," *Journal of Law, Economics, and Organization* 20, no. 2 (October 1, 2004): 415–37, accessed June 21, 2016, <http://jleo.oupjournals.org/cgi/doi/10.1093/jleo/ewh040.436>.

¹¹² Olwan, *Intellectual Property and Development: Theory and Practice*, 193.

¹¹³ Ibid. 245.

¹¹⁴ Li, "Intellectual Property and Innovation: A Case Study of High-Tech Industries in China." 302.

¹¹⁵ Christopher Gulinello, "Engineering a Venture Capital Market and the Effects of Government Control on Private Ordering: Lessons from the Taiwan Experience," *Geo. Wash. Int'l L. Rev.* 37, no. 4 (2005): 870.

¹¹⁶ Ibid. 871-874.

effectively or ineffectively in stimulating innovation. In this section, the literature introduces the subsidized policies to support the innovations in SMEs. The previous scholars prove the effectiveness of the policies that the government designed for directly supporting R&D or SMEs and this section also discusses those results in practice.

When analyzing the government procurement policy in China, Chen believes that the subsidize policies in China are weaker than the other countries because of their backward realization to support SMEs through government procurement and other policies other than to merely support state-owned enterprises that used to assist the government to dominate the economy.¹¹⁷

Besides tax policies, the government also creates other policies and regulations to instruct firms' behaviors in the market. However, many scholars are hesitant to use them as efficient measures to encourage growth of SMEs and their innovations.

On the one side, Shapiro believes that market power can stimulate innovation, especially joint-invention, stronger and more efficiently than any awarding policies.¹¹⁸ On the other side, Wendland argues that state interventions can effectively eliminate market failures to create incentives to do more R&D and innovations.¹¹⁹

With the goal of state aid rules, that is to avoid distortion in the single market and promote the competitiveness of industry in Europe, Wendland believes that the state aid rules created by the E.U. Commission bridges the line between R&D and innovation promotion on one side, and efficient competition on the other side.¹²⁰ Furthermore, Salter and Smith conclude that regulatory policies are important to industrial development because it can strengthen consumer confidence by controlling market in some degree.¹²¹

¹¹⁷ Chen, "Challenges in Designing Public Procurement Linkages: A Case Study of SMEs Preference in China's Government Procurement," 158-159.

¹¹⁸ Carl Shapiro, "Prior User Rights," *The American Economic Review* 96, no. 2 (2006): 95, accessed June 21, 2016, <http://www.jstor.org/stable/30034621>.

¹¹⁹ Wendland, "R&D & I-State Aid Rules at the Crossroads-Taking Stock and Preparing the Revision," 389-390.

¹²⁰ Ibid. 391-407.

¹²¹ Brian Salter and Michael E Smith, *The UK's Stake in the Biotechnology Debate: Global Competition and Regulatory Politics*, 2002, 8, accessed June 21, 2016, <http://www.cepr.org/meets/wkcn/3/3517/papers/salter.pdf>.

In the empirical study with the U.S. firms in the semiconductor industry, Ziedonis and Hall show how pro-patent policies rather than the market are effectively encourage the firms patenting so as to improve their management skills on the process of innovating and ultimately to improve their productivity of R&D.¹²² When studying green innovation, Reichman et al. argue that green gas emission policy can be an effective inducement to innovation only if the policy can be credible to the private sector over a long term.¹²³ With the data of OECD countries between 1978 and 2003, the empirical study conducted by Johnstone, Hascic and Popp shows that public policy has a significant influence on the development of the innovation of renewable energies.¹²⁴ However, the economic analysis by Smith presents that the regulatory structure of the E.U. declines its biotechnology market.¹²⁵

Naturally the mechanism of government policies cannot be perfect, even to its supporters. While there are some regulations, such as GBER (the General Block Exemption Regulation of 2008), established by the E.U. commission, to be concern about the growth of SMEs, Wendland admits that most of the state aid rules favor larger firms over SMEs and prefer to benefit high-tech industries.¹²⁶ Also, if regulations are too intrusive, they reminds that companies will remove their global business to the other countries.¹²⁷

Denivolo and Franzoni conclude that policies must be designed as a supplement of law to trade-off the incentives of innovation and the demands of encouraging diffusion when there is a puzzle that the former goal asks for strong IPRs protection but hurts the latter aim to foster competition.¹²⁸

¹²² Rosemarie Ham Ziedonis and Bronwyn H. Hall, "The Effects of Strengthening Patent Rights on Firms Engaged in Cumulative Innovation: Insights from the Semiconductor Industry," in *Advances in the Study of Entrepreneurship Innovation Economic Growth*, vol. Volume 13, 2001, 176.

¹²³ Reichman et al., "Intellectual Property and Alternatives: Strategies for Green Innovation," 360.

¹²⁴ Nick Johnstone, Ivan Hascic, and David Popp, "Renewable Energy Policies and Technological Innovation: Evidence Based on Patent Counts," *Environmental and Resource Economics* 45 (2010): 151.

¹²⁵ Smith, "Regulating Science and Technology: The Case of the UK Biotechnology Industry," 198.

¹²⁶ Wendland, "R&D& I-State Aid Rules at the Crossroads-Taking Stock and Preparing the Revision," 393.

¹²⁷ Smith, "Regulating Science and Technology: The Case of the UK Biotechnology Industry," 199.

¹²⁸ Vincenzo Denicolò and Luigi Alberto Franzoni, "Weak Intellectual Property Rights , Research Spill-Over and the Incentive to Innovate," *Am Law Econ Rev* 14 (2012): 111–40, accessed June 21, 2016,

Besides the instrument regulation of IPRs, Gervais believes that other public policies improving competition, basic science or public knowledge should be more effective in stimulating innovation, especially in developing countries.¹²⁹ Moreover, Maskus and Okediji argue that merely having public policies is not enough to spur practical and advanced innovations, which have the demands of subsidies and other support as well.¹³⁰

In the case of China, the former president Hu Jintao announced that the strategy to establish and innovative society in China is through a promoted legal system,¹³¹ including monitoring the administration by the governments, or designing and improving laws, policies and other regulations. Hence, overall, the above thoughtful discussions and suggestions should be valuable to be considered by Chinese legislatures and scholars to build this legal environment.

II. Problems – Efficiency of Economic Instrument by Governments in Fostering Innovation by SMEs

Chapter 3 explains how innovators are compensated with the IP regimes around the world. However, innovators may not be able to be fully compensated for their R&D costs from the market under the IP regime due to market failures¹³² or their weak competitiveness in the market.¹³³ Governments thus directly or indirectly subsidize them to fill the gap between the compensation from market and their R&D costs to encourage them to act for public interests,

http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1825045. 113.

¹²⁹ Gervais, "Of Clusters and Assumptions: Innovation as Part of a Full TRIPS Implementation," 2377.

¹³⁰ Maskus and Okediji, "Legal and Economic Perspectives on International Technology Transfer in Environmentally Sound Technologies," 394.

¹³¹ Jintao Hu presented this idea in the Meeting of National Technical Innovation in 2006, accessed June 21, 2016, http://news.xinhuanet.com/st/2006-01/09/content_4030855.htm.

¹³² Besides the inefficient competition problem I raise in the problem of constructing a strong or weak IP regime, market failures also include public good, externalities, indivisibility, duplication R&D and other effects impeding the R&D incentives of innovators in the market. Greenhalgh and Rogers, *Innovation, Intellectual Property, and Economic Growth*, 18-22.

¹³³ The competitiveness of the products does not only depend on the particular technology, but also depend on the market shares of a firm. Also see, *Ibid.* 141-142.

such as to develop green technologies.

Generally, tax policies are a type of popular economic instrument that governments use for every type of their political goals, not limited to directly encouraging R&D, and it is effective in some levels.¹³⁴ Other than tax policies, economic instruments by governments to generate innovation incentives of SMEs have multiple types, sources, forms and sizes. For example, governments directly invest in SMEs and provide them grants to support their R&D, or indirectly invest in them through VC funds. Alternatively, governments can award or give prizes to the firms when they have done particular behaviors relating to public good or innovation. The sources of these economic instruments can be state governments or local governments.

In contrast to the consensus on effects of tax credits by scholars, although scholars basically agree on the importance of subsidies, prizes or rewards¹³⁵, there is a huge fight on the efficiency of having government funding, and the efficiency in fact fluctuates with time, areas, industries, degrees and forms of funding, which was proved by the statistics or empirical studies by the scholars mentioned in the literature review. In practice, many countries provide government funding as an economic instrument to encourage R&D and induce the development of some high-tech industries, such as the pharmaceutical industry, the biotechnology industry, and the software industry.¹³⁶ However, although many scholars have proved that government grants are necessary,¹³⁷ other scholars doubt this conclusion and compare government funding with other

¹³⁴ As I present in the literature review, both developed countries and developing countries use tax credits to subsidize R&D in particular size firms, such as SMEs, and in particular industries, and encourage other types market behaviors, such as investment in the innovative firms, SMEs, or the firms in these particular industries. The empirical results show that their efficiency in different areas and different time are different.

¹³⁵ Fisher, Hall, Greenhalgh and Rogers, Reichman et al., Olwan, Dosi and Stiglitz, Maskus and Okediji support to have a regime with subsidies, prizes and awards providing R&D incentives, although Burlamaqui and Cimoli worry its high costs.

¹³⁶ Cumming and Johan studied the state funding in the U.K. for pharmaceutical firms. Nuvolari and Tartari mentioned that Germany governments provided public funding to agricultural research. The statistic by Allarakhia shows that developing countries provide government funding to agricultural innovation and biotechnologies. Olwan uses Jordan's example to present how its software industry was successfully created by government funding. See Cumming and Johan, "Phasing Out an Inefficient Venture Capital Tax Credit." See also, Nuvolari and Tartari, "Innovation, Appropriability and Productivity Growth in Agriculture: A Broad Historical Viewpoint." See also, Allarakhia, "Mode of Entry for Emerging Markets: An Ex Ante and Ex Post Perspective of the Open Source Development and Management of Biotechnology Knowledge Assets." Also see, Olwan, *Intellectual Property and Development : Theory and Practice*.

¹³⁷ For example, Gulinello, Li, Allarkhia, Coriat and Orsenigo theoretically discuss the importance of government funding in supporting R&D and innovators, or emphasize the importance by the case of Taiwan and China with empirical evidence.

measures for achieving the same function. These measures include equity investments in firms by government, investments from private capital markets, and IP regimes.¹³⁸

Some of the previous studies show that the former two types of economic instruments by government, tax credits and prizes, are more effective in encouraging R&D in high-tech industries, especially by SMEs. Reenen, Smith, Cumming and Johan, Gompers and Lerner studied the experiences of the U.K., Canada, the U.S., and the E.U. members and make this suggestion. Comparatively, the scholars, such as Scotchmer and Olwan, who studied the efficiency of government funding, favor IP regime less.

There are, nevertheless, three main issues remaining in these previous studies. First, the scholars who prefer those former two types of economic instruments to government funding merely studied the cases and data of developed countries. Therefore, the value of their suggestion to the governments of developing countries is limited. One reason is that the innovation capabilities in different economies are different.¹³⁹ Also, the financial environments of private or public investment in these two groups of economies are different because most developing countries usually do not have a mature capital market¹⁴⁰ in which equity investments through different investors, such as government, private investors or public investors, can be efficiently made. Thus, it is hard to directly apply the suggestion meant for developed countries to developing countries.

Fortunately, the methodologies adopted in that previous empirical literature studying the efficiency of government funding in particular areas or markets can be reasonably adopted by this study. From my analysis of the efficiency of government funding in China, other developing countries can understand this first issue better because a developing country case is closer to

¹³⁸ OECD, *Government R&D Funding and Company Behaviour. Measuring Behavioural Additionality*. See also, Cumming and Johan, "Phasing Out an Inefficient Venture Capital Tax Credit." See also, Olwan, *Intellectual Property and Development: Theory and Practice*. Also see, Scotchmer, "The Political Economy of Intellectual Property Treaties."

¹³⁹ One difference is that the innovators in developing countries are basically innovation followers, far away falling behind the innovators in developed countries. Because this, their innovation environments are different in public goods, infrastructures and IP regime.

¹⁴⁰ For example, Barkoczy and Edmundson mentioned that the VC markets in the countries other than the U.S. are relatively immature. Barkoczy and Edmundson, "Australasian and South East Asian Venture Capital Tax Expenditure Programs." 56. Thus, to structure an efficient financial market in China and developing countries will be discussed in this research.

their situations than the previous studies which used the cases of developed countries.

The second issue is that the previous literature merely independently tested the efficiency of tax credits, awards, prizes, and government funding in encouraging R&D, and the literature did not count the mutual effects among these various policies, which are not limited to the policies particularly supporting R&D, but also include the policies to support SMEs or IP applications. The subsidized innovative firms that have been previously studied may qualify the conditions of several different supporting policies in the same period.¹⁴¹ Without controlling for the other types of subsidies, the conclusions of inefficiency or efficiency of solely tax credits, awards, prizes, or government funding may not be sufficiently robust. In order to understand their mutual effects on the incentives of R&D in SMEs, this study will test these types of subsidies both separately and jointly.

The third problem of the existing literature is about the ignored interacted effects between the IP regime and government funding on the R&D incentives of firms. Both of these systems are artificially designed by governments.¹⁴² The IP regime ex post compensates the innovators through a market,¹⁴³ whereas the government funding ex ante compensates the innovators based on the government's blueprint in some industries or public interests.

The previous studies conducted by Scotchmer and Olwan compare the efficiencies of the IP regime and government funding independently, but they ignore the fact that an IP regime has been established in many countries and cannot be abolished even if it could be shown to be inefficient in stimulating the incentives of innovation in practice.¹⁴⁴ Rather than selecting which

¹⁴¹ For example, SBA provides grants, tax credits, assistance to find investors and loans to SMEs. The grants may be not only from a single resource because besides subsidizing SMEs, different department of governments provide grants to firms to encourage their innovation in particular industries. Moreover, local governments also provide subsidies to the firms. Detail knowledge can be found from the website of SBA. <https://www.sba.gov>

¹⁴² Taking the U.S. as an example of common law countries, IP laws are designed by federal government, and the applications of patents are processed through PTO, a government agency. In China, a civil law country, IP laws are designed by the legislatures in the interests of the country, and the applications of patent are processed by SIPO, a government agency, and the registrations of copyrights are authorized by Copyright Protection Center of China, also an institution organized by Chinese government.

¹⁴³ Recall the economics theory, how IPRs create monopoly to encourage innovation. See Greenhalgh and Rogers, *Innovation, Intellectual Property, and Economic Growth*, 32-34.

¹⁴⁴ Scotchmer, "The Political Economy of Intellectual Property Treaties." See also Olwan, *Intellectual Property and Development: Theory and Practice*.

regime is more effective so as to suggest that governments of developing countries should strengthen one over the other, like in Scotchmer's and Olwan's studies, it is better to suggest how governments should efficiently adjust their funding to firms in a proper IP regime or how governments should use subsidies or subsidized policies to facilitate patent commercialization to compensate innovators in an inefficient market.¹⁴⁵ This is exactly the path of logic that this study is going to take.

III. Research Questions and Hypotheses

To respond the discussed problems with regards to the government intervention in the innovation by SMEs, this section lists the concerns that this research structures and the corresponding hypothesis, including:

What is the efficiency of the economic instruments by the government in stimulating innovation by SMEs? Can those improve the R&D capabilities and commercialization by SMEs? In precise, is the capital from the government, including tax credits for innovative firms or for the "high-tech" firms, grants, or other subsidies associated with the SMEs' R&D inputs and outcomes in revenue?

One hypothesis is that revenue and net profit would vary as the functions of R&D intensity (a rate of R&D investment over employee), outcomes of R&D investment in the form of various types of IPRs, including utility patents, utility models, design patents and software copyrights, and inputs of R&D from government funding, prizes, and tax credits for subsidizing and encouraging R&D. The other hypothesis is that the effects of these inputs are through their interaction with R&D intensity of the SMEs and the outcomes in the form of IPRs.

¹⁴⁵ Even though Murphy and Orcutt have studied the issues on patent subsidies, their interpretation of laws in Chinese sometimes is not accurate. For example, they mentioned that the SIPO Patent Subsidy Program is restricted to SMEs, public institutions and government research institutions. This is not true, and the rule of subsidizing firms never defines the types of subsidized targets. Hence, the meaning of their suggestion for Chinese subsidy programs is limited. William J. Murphy and John L. Orcutt, "Using Valuation-Based Decision Making to Increase the Efficiency of China's Patent Subsidy Strategies," *Cardozo Law Review*, 2013, 116-46.

IV. Data and Methodology

This part explains the data and methodology that this research adopts. Section 1 introduces the background of the observations. Then, Section 2 explains the variable selections, and Section 3 describes the data distributions. In Section 4, the model designs with the data and the variables are discussed.

1. Data Background

The research adopts firm-level data and the firm-level data are collected from some of the public firms in Zhongguan-Cun Science Park and Zhangjiang Hi-Tech Park, the top two most significant national science parks in China. This section introduces the background of the two parks. Due to the complexity of the circumstances in China, which is such a big country both in geography and population, learning about their background is necessarily helpful to understanding the reason why I exploit the enterprises in the two science parks to represent the innovative SMEs and the relevant issues in China. Based on my observations, these two parks use two extremely different styles of policy to facilitate their domestic registered enterprises, and other cities copy their modes at different levels.

Section 1.1 introduces the background of Zhongguan-Cun Science Park, and Section 1.2 introduces the background of Zhangjiang Hi-Tech Park.

1.1. Zhongguan-Cun Science Park

Learning from the experience of Silicon Valley, the P.R.C. State Council established Zhongguan-Cun Science Park (Zhongguan-Cun) in the 1980s as the first high-tech park in China

and named it as “Beijing New Technology Industrial Development Trial Zone.”¹⁴⁶ This was the beginning of technology commercialization and entrepreneurship in China.¹⁴⁷ Moreover, since then, the national government and the Beijing government have been actively and strongly supporting the construction of Zhongguan-Cun through a large number of policies and a great amount of funding.¹⁴⁸

Zhongguan-Cun is located in Beijing and is surrounded by 39 universities or colleges, including Tsinghua University and Peking University.¹⁴⁹ In 2007, these universities held 56 of “the highest state-level disciplines,” which represented 77.8% of these disciplines in total.¹⁵⁰

In 2009, the State Council first authorized it as the “Zhongguan-Cun National Demonstration Zone” and started testing multiple supporting policies with the firms there.¹⁵¹ Besides providing beneficial tax policies to support doing innovation by the firms in Zhongguan-Cun, the government of China decided to test its most advanced policies of financial reform in Zhongguan-Cun. Also, it organized the firms in Zhongguan-Cun to collect innovations for some national projects covering several industries, such as green technology, electronic information and the biological and pharmaceutical industry. As a probable result, based on the

¹⁴⁶ “Zhongguan-Cun Science Park Profile,” accessed May 31, 2015, http://en.zhongguancun.gov.cn/2013-12/04/content_17148863.htm.

¹⁴⁷ “(Zhongguan Cun) Fazhan Licheng((中关村)发展历程)[Path of the Development (of Zhongguan-Cun)],” 2009, accessed June 21, 2016, <http://www.zgc.gov.cn/sfqgk/55179.htm>.

¹⁴⁸ The P.R.C. State Scientific and Technological Commission authorized to organize Zhongguan-Cun into five tiny technical parks and sometimes applied different tested policies on them. In 1999, the five technical parks were extended to ten, and finally extended to sixteen in 2009. Ibid.

¹⁴⁹ Zhongguan-Cun Keji Yuan Guanweihui(中关村科技园管委会)[Administrative Committee of Zhongguan-Cun Science Park], “Zhongguan Cun Shifan Qu Gaoxiao Keji Ziyuan Diaocha Ji Jiexi (Zhaiyao)(中关村示范区高校科技资源调查及解析 (摘要)) [The Investigation and Analysis of Technology Sources by Universities in Zhongguan-Cun Demonstration Zone (Abstract)],” accessed May 31, 2015, <http://www.zgc.gov.cn/fzbg/yjkt/70110.htm>.

¹⁵⁰ Ibid. The title was named by the P.R.C. State Council and selected by the Department of Education among all universities or colleges in China. In 2014, the State Council abolished this mechanism. See also Zhonghua Renmin Gonghe Guo Guowu Yuan(中华人民共和国国务院)[The State Council of the P.R.C.], *Guowuyuan Guanyu Quxiao He Xiafang Yipi Xingzheng Shenpi Xiangmu De Jueding(国务院关于取消和下放一批行政审批项目的决定)[Decisions on Abolishing or Releasing Some Administrative Projects by the State Council]*, 2014, accessed June 21, 2016, http://www.gov.cn/zwqk/2014-02/15/content_2602146.htm.

¹⁵¹ Zhonghua Renmin Gonghe Guo Guowu Yuan(中华人民共和国国务院)[The State Council of the P.R.C.], *Guowuyuan Guanyu Tongyi Zhichi Zhongguan-Cun Kejiyuanqu Jianshe Guojia Zizhu Chuangxin Shifanqu De Pifu(国务院关于同意支持中关村科技园区建设国家自主创新示范区的批复)[The Response to Zhongguan-Cun Science Park in the Construction of the National Demonstration Zone by the State Council]*, 2009, accessed June 21, 2016, <http://www.zgc.gov.cn/zcfg10/gj/56120.htm>.

statistics by SIPO, Beijing is always the city having the most patent applications every year.¹⁵²

In December 2010, Zhongguan-Cun established the “Zhonggua-Cun Innovation Platform” to bridge universities, state laboratories, large state-owned enterprises and high-tech firms.¹⁵³ The administrative agency of Zhongguan-Cun organizes its officers in this platform, the officers from the Beijing government and some national departments to work in eight professional institutions responsible for authorization of projects, technical finance, attraction of professionals, government procurement, application commercialization, policy testing, policy construction, science center and modern service industries to facilitate the operation and development of the domestic firms, their innovation, and commercialization of their technology.¹⁵⁴

Besides the plentiful public sources provided by the governments, due to its location in the capital of China, private sources are also accumulated in Zhongguan-Cun. For example, in 2009, 21 funds holding 980 million Yuan in equity investment registered in Haidian Park, the central park of Zhongguan-Cun, and over 154 funds in equity investment had registered there.¹⁵⁵ Between 2009 and 2011, both the amount of PE investments and the number of the cases of PE investments in Beijing were the highest among all the provinces.¹⁵⁶

Until June 2013, there have been 211 public enterprises in Zhongguan-Cun.¹⁵⁷ On the one hand, 30 enterprises of them are listed on SME board of Shenzhen Stock Exchange. In 2013, they took 4.28% of the total number of the listed SMEs on SME board and valued 20.85% of the

¹⁵² Data are collected from SIPO.

¹⁵³ “Zhongguan Cun Chuangxin Pingtai(中关村创新平台)[Zhongguan-Cun Innovation Platform],” accessed June 3, 2015, <http://www.zgc.gov.cn/zgccxpt/>.

¹⁵⁴ Ibid.

¹⁵⁵ Zhongguo Fengxian Touzi Yanjiu Yuan(中国风险投资研究院)[China VC Investment Research Institute], *Zhongguo Fengxian Touzi Nianjian 2010(中国风险投资年鉴 2010)[China Venture Capital Yearbook 2010]* (Minzhu Yu Jianshe(民主与建设)[Democracy and Construction], 2010), 112.

¹⁵⁶ Ibid. 150. See also, Zhongguo Fengxian Touzi Yanjiu Yuan(中国风险投资研究院)[China VC Investment Research Institute], *Zhongguo Fengxian Touzi Nianjian 2012(中国风险投资年鉴 2012)[China Venture Capital Yearbook 2012]* (Minzhu Yu Jianshe(民主与建设)[Democracy and Construction], 2012), 181. See also, Zhongguo Fengxian Touzi Yanjiu Yuan(中国风险投资研究院)[China VC Investment Research Institute], *Zhongguo Fengxian Touzi Nianjian 2011(中国风险投资年鉴 2011)[China Venture Capital Yearbook 2011]* (Minzhu Yu Jianshe(民主与建设)[Democracy and Construction], 2011), 150.

¹⁵⁷ Shuhua(田书华) Tian, *Zhongguan Cun Guojia Zizhu Chuangxin Shifan Qu Shangshi Gongsi Jiben Qingkuang Bijiao Fenxi(中关村国家自主创新示范区上市公司基本情况比较分析)[Comparative Analysis on Public Firms in Zhongguan-Cun National Demonstration Zone]*, 2013, 1.

whole value of SME Board. On the other hand, another 52 enterprises are listed on GEM, Growth Enterprise Market, of Shenzhen Stock Exchange.¹⁵⁸ In 2013, they took 14.65% of the total number of the traded enterprises on GEM, and valued 7.79% of GEM. Moreover, there have been more than 50 enterprises listed on the two main boards of China and another 79 enterprises listed on the Stock Exchanges of the countries other than Mainland China.¹⁵⁹

1.2. Zhangjiang Hi-Tech Park

In 1992, Zhangjiang Hi-Tech Park (Zhangjiang) was established in Shanghai, China, to be one of China's first state level high-tech zones.¹⁶⁰

Besides a large number of the universities or colleges, such as Fudan University, surrounding it, it has many professional training institutes to train the employees working in its enterprises. In 2006, it founded its own training institute, Shanghai Zhangjiang Institute for Innovation, specifically for supporting various demands during innovation.¹⁶¹ Moreover, both the Chinese universities and foreign universities have set innovation centers in Zhangjiang.¹⁶² Beyond the basic function of training, not only can they cooperate with the domestic firms in Zhangjiang to commercialize their technologies, they can also facilitate innovation by the firms and stimulate entrepreneurship.¹⁶³

¹⁵⁸ SME board and GEM are second boards of Shenzhen Stock Exchange and Shanghai Stock Exchange.

¹⁵⁹ Shuhua Tian, Comparative Analysis of the Public Corporations in Zhongguang-Cun National Innovation Model Park, China Galaxy Securities, (Jun, 22. 2013), accessed June 21, 2016, http://www.chinastock.com.cn/yhwz_postdoc.do?methodCall=getResultsInfo&docId=3522355

¹⁶⁰ “张江高科技园概况[Introduction of Zhangjiang Hi-Tech Park],” accessed June 6, 2015, <http://www.zhangjiang.net/Default.aspx?tabid=152>.

¹⁶¹ “(Zhangjiang) Jiaoyu Peixun)((张江)教育培训][(Zhangjiang) Education and Training],” accessed June 2, 2015, http://www.zjpark.com/Second.aspx?infoitem_id=318&infoitem_pid=3.

¹⁶² For example, UC Berkeley College of Engineering created the Z-BEI Center, the Shanghai Zhangjiang Berkeley Engineering Innovation Center, in Zhangjiang. See Shanghai Municipal People's Government, “City ‘Silicon Valley’ and Berkeley Join up,” 2013, accessed June 21, 2016, <http://www.shanghai.gov.cn/shanghai/node27118/node27818/u22ai74060.html>.

¹⁶³ Zhenying Yang (杨珍莹), “Shanghai Zhangjiang Bokeli Gongcheng Chuangxin Qiyong[上海张江伯克利工程创新中心启用][Z-BEI Center Starts Operation],” *Pudong Shibao*(浦东时报)[*Pudong Times*], 2013, http://www.chinadaily.com.cn/hqgj/jryw/2013-11-19/content_10620433.html.

Different from Zhongguan-Cun nursing entrepreneurship altogether with various sources from universities, public laboratories and the government, Zhangjiang firstly and intentionally collects and organizes the firms from the five main industries: the industry of information technology, the biological and pharmaceutical industry, the entertainment industry, the mechanical industry and the green technology industry.¹⁶⁴ For the financial activities or innovative activities, Zhangjiang provides flexible subsidies, funding or other supportive policies to support their development and the construction of the particular industries their businesses belong to.¹⁶⁵

Based on the 2012 statistics, over 90% of the Zhangjiang enterprises are in small or medium sizes, and most of them are small enterprises.¹⁶⁶ Even though the utility patent applications in Shanghai are usually less than Beijing, due to the clearly categorized industries to be supported in Zhangjiang, the total number of all three types of patent applications, including utility patent applications, utility model applications and design patent applications, are on the same level with that in Beijing and much higher than Shenzhen and other significant cities in China.¹⁶⁷

The administrative agency of the Pudong New Area, a district of Shanghai and covering many enterprises of Zhangjiang Hi-Tech Park, costs at least 200 million Yuan on funding technical development and freely providing to the local SMEs every year.¹⁶⁸ Indirectly, the agency had invested over 20,000 million Yuan on funding some VC funds since 2006.¹⁶⁹

¹⁶⁴ “Zhangjiang Gaokeji Yuan Gaikuang(张江高科技园概况)[Introduction of Zhangjiang Hi-Tech Park].”

¹⁶⁵ Zhangjiang Gaoxin Keji Yuanqu Guanweihui(张江高新技术园区管委会)[Administrative Committee of Zhangjiang High-Tech Park], *Shanghai Shi Zhangjiang Gaokeji Yuanqu Chanye Fuchi Guanli Banfa(上海市张江高科技园区产业扶持管理办法)[Supportive and Administrative Methods of Shanghai Zhangjiang Hi-Tech Park for Industries](effective Jan. 1, 2011)*, n.d., <http://www.zhangjiang.net/Default.aspx?tabid=278&ItemId=146&CategoryId=6>. See also, *Shanghaishi Zhangjiang Gaokeji Yuanqu Qiye Fazhan Fuchi Banfa(上海市张江高科技园区企业发展扶持办法) [Supportive Methods for Enterprises Development of Shanghai Zhangjiang Hi-Tech Park]*, 2011, accessed June 21, 2016, <http://www.zhangjiang.net/Default.aspx?tabid=278&ItemId=147&CategoryId=6>.

¹⁶⁶ “Brief of Zhangjiang Hi-Tech Park and Zhangjiang Group,” 2013, accessed June 21, 2016, <http://www.zjpark.com/en/rules/about>.

¹⁶⁷ In some years, the number of all types of patent applications in Shanghai and Beijing can be triple times of that number in Shenzhen. Statistic by SIPO.

¹⁶⁸ “Zhangjiang Juban Chuangyeban Rongzi Luntan(张江举办创业板融资论坛)[Zhangjiang Held a GEM Financial Forum],” 2009, accessed June 21, 2016, <http://finance.sina.com.cn/stock/t/20090626/09202916567.shtml>.

¹⁶⁹ Ibid.

Furthermore, these VC funds attracted over 30,000 million Yuan from local and foreign investors and at least one third of their investments would be invested in the local enterprises.¹⁷⁰

Actually, in the history of China, Shanghai is always an innovative city in finance. In 2013, when the OTC (over-the-counter) market started in China, not only had Shanghai involved this market to sell PE loans, 95 private enterprises listed their share price on a professional platform established in Shanghai.¹⁷¹ Other than Beijing, Shanghai usually holds the most registered VC or PE investment funds among all other cities in China.¹⁷² In an environment of investment like this, Zhangjiang has 58 SMEs listed on the SME board or the GEM board of the Shenzhen Stock Exchange by 2013.

2. Data and Data Sources

In order to further explore the research questions raised in Section III, and follow up the prior literature, this section introduces the data that this research adopts. The data are at firm level and between 2009 and 2013. With regards to the specific government monetary supports for SMEs, the data are at firm level. Section 2.1 introduces the sources of the firm-level data in innovation and their sources. Section 2.2 introduces the firm-level data in other economic instruments by the government. The two sections explain the variables I select and the process of collecting and coding the data into those variables.

2.1.Firm-Level Data in Innovation

For the reliability and the availability of the firm-level data that the research needs, the samples of the research cover only all 82 public SMEs in the GEM and the SME Board of the

¹⁷⁰ Ibid.

¹⁷¹ Zhongguo Fengxian Touzi Yanjiu Yuan(中国风险投资研究院)[China VC Investment Research Institute], *Zhongguo Fengxian Touzi Nianjian 2014(中国风险投资年鉴 2014)*[China Venture Capital Yearbook 2014] (Minzhu Yu Jianshe[民主与建设][Democracy and Construction], 2014), 117.

¹⁷² Ibid. 234.

Shenzhen Stock Exchange between 2009 and 2013 from Zhonggun-Cun and all 58 public SMEs on the two boards from Zhangjiang. Moreover, these public SMEs are comparatively more mature, so any serious issues relating survival will not be discussed in this research and also do not disturb other issues relating to the research questions.¹⁷³ Hence, I can acquire their business information from their prospectus and annual reports.

To learn the basic characteristics of the SMEs, the data collection covers the revenue of each SME every year, its net profits, the number of its employees and the category of its industry.¹⁷⁴ Besides presenting sizes of the SMEs, revenue can present the growth and competitiveness of the SMEs.¹⁷⁵

First, I collect firm-level data to learn the innovative activities and IP activities by SMEs. To learn the former, I collect their R&D expenditure per year, R&D intensity, represented by R&D-to-employee ratio and their R&D-to-revenue ratio to learn their input of innovations.

The R&D expenditure tells the amount of the input of technology investment by an SME, which can represent the R&D capabilities of the SME. In accounting, different stages of the process of R&D make the relevant expenditures go to costs or expenses. When it has been recorded as costs, it cannot be discriminated from other types of costs in the running of the business of the SME. Hence, if an SME revised its R&D expenditure in its further annual reports, I record the higher number as their R&D expenditure.

Companies in various sizes or various industries, however, may have different extent of

¹⁷³ The SMEs are required to disclosure their recent three years' accounting reports. The disclosure requirements of GEM are more than that of the main board, and the disclosure requirements of SME adopt that of the main board. Rule 5.1.3, section5, *Shenzhen Zhengquan Jiaoyisuo Gupiao Shangshi Guize* (深圳证券交易所股票上市规则)[Public Securities Rules for Shenzhen Stock Exchange], 2014, [http://www.szse.cn/main/files/2014/11/28/深圳证券交易所股票上市规则\(2014年修订\).pdf](http://www.szse.cn/main/files/2014/11/28/深圳证券交易所股票上市规则(2014年修订).pdf). 16. See also, Rule 26, *Gongkai Faxing Zhengquan De Gongsi Xinxi Pilu Neirong Yu Geshi Zhunze Di 35 Hao* (公开发行证券的公司信息披露内容与格式准则第35号)[Regulation of Disclosure Content and Format for the Firms with Public Traded Securities, No. 35], 2014, 9, accessed June 21, 2016, <http://www.szse.cn/main/files/2014/06/19/463467907250.pdf>.

¹⁷⁴ Hall et al. find that most of the previous empirical studies show that industry could be an important factor in innovating, patenting and litigating. Hall et al., "The Choice between Formal and Informal Intellectual Property: A Review," 410-418.

¹⁷⁵ The size definitions of SMEs in different industries are different. They are usually defined by revenue. Zhongguo Guojia Fagai Wei(中国国家发改委)[National Development and Reform Commission] et al., *Zhongxiao Qiye Huaxing Biaozhun Guiding* (中小企业划型标准规定)[Size Definition of SMEs], 2011, accessed June 21, 2016, <http://www.miit.gov.cn/n11293472/n11293832/n11293907/n11368223/13912671.html>.

capabilities of R&D and demand of R&D activities. Therefore, I need another R&D relative variable from the annual reports of the SMEs to tell their attitudes on doing innovation, even though I do not use questionnaires or interviews to acquire the data.¹⁷⁶ Here, the R&D-to-revenue ratio can tell the importance of how an SME treats R&D in its business operation. R&D-to-revenue is a measure usually indicating R&D intensity.¹⁷⁷ The Chinese governments also adopt this ratio to measure the innovation by firms and then decide relevant subsidized policies to apply to the firms.¹⁷⁸ In order to distinguish from this standard adopted by the governments, another scaled measure for R&D that this research adopts most frequently is the R&D intensity, represented R&D-to-employee ratio. In Ziedonis's papers, she consistently adopts this ratio to represent R&D intensity.¹⁷⁹

Moreover, I look into the IP activities of the SMEs to learn their outcome of innovations and their reflections on the IP regime.¹⁸⁰ In precise, the data include the number of annual filed applications for utility patents, utility models and design patents, issued utility patents, utility models and design patents, as well as registered software copyrights. All patent relevant data are collected from the SIPO database. The registered software copyrights are known from the prospectus and annual reports. If the records in these two sources are not clear, I trace back the original records from the CPCC (the Copyright Protection Center of China).

¹⁷⁶ The decisions of an SME are made by groups of people, not just a person. Therefore, to understand any attitudes of the decision groups of the SME, questionnaires or interviews are not object and accurate enough, even doing the survey with their CEOs. Comparatively, using the data reflecting their innovative activities in the past can be a better approach to learn their true plans and attitudes on innovation.

¹⁷⁷ Scholars, such as Bessen, Maskin, Hunt and Yrkkö, usually adopt the ratio of R&D investment to revenue to represent R&D intensity. James Bessen and Eric Maskin, "Sequential Innovation, Patents, and Imitation," *RAND Journal of Economics* 40, no. 4 (2009): 611–35. See also, James Bessen and Rober M. Hunt, *An Empirical Look at Software Patents*, PhD Proposal, 2004. See also, Jyrki Ali-Yrkkö, "Impact of Public R&D Financing on Private R&D: Does Financial Constraint Matter?," *ENEPRI Working Paper*, 2005.

¹⁷⁸ Chapter 3, § 10.4. See, Zhonghua Renmin Gonghe Guo Hexue Jishu Bu(中华人民共和国科学技术部)[The Ministry of Science and Tehnology of the P.R.C.], Zhonghua Renmin Gonghe Guo Caizheng Bu(中华人民共和国财政部)[The Ministry of Finance of the P.R.C.], and Guojia Shuiwu Zongju(国家税务总局)[The P.R.C. State Administration of Taxation], *Gaoxin Jishu Qiye Rending Guanli Banfa*(高新技术企业认定管理办法)[*Hi-Tech Enterprises Certification Methods*], 2008.

¹⁷⁹ Bronwyn H Hall and Rosemarie Ham Ziedonis, "The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995," *RAND Journal of Economics* 32, no. 1 (2001): 101–28. Also see, Rosemarie Ham Ziedonis, *When the Giants' Shoulders Are Crowded: Fragmented Rights and Patent Strategies in Semiconductors*, 2002.

¹⁸⁰ Patent and copyright are significant for innovators to protect their achievement of innovation or staged achievement of innovation. Although they can protect their innovations through trade secrets, our literature review has compared the advantage and importance of IP protection with them.

In the process of data collecting, however, there are still some limitations. First, it is impossible to include the IP information of both parent companies and all subsidiaries, because the annual reports of the SMEs may not disclose all of their subsidiaries. Moreover, with a huge amount of the subsidiaries of the SMEs, the controls of these subsidiaries are complex. Some of them are completely controlled by the parent company, but some are not. The influence of the SMEs as a whole on the R&D in the subsidiaries, hence, is difficult to declare. Therefore, even though the data of R&D that are directly recorded from the prospectus and annual reports of the SMEs may include both the parent companies and their subsidiaries, the data of patents probably only count the parent firm.

Another limitation is caused by the exclusive licensing patents or pool licensing patents. The technology cooperation, including but not limited to these two types, is vaguely recorded in the SMEs' annual reports. For example, following the first limitation, the use of licensing is rare between the parent firms and their subsidiaries by these enterprises.¹⁸¹

Even if an annual report may disclose some information about licensing patents, or technology cooperation, it is hard to define the level of endeavor that the SME has spent on that output. In reality, the Statistic from SIPO shows that the technology transactions as a whole are still rare in the market of China, where all registered patent transactions are less than ten percent of the patent filing a year. Also the SMEs in this study have almost none of the registered records so as to be impossible to trace them by the SMEs, I do not include these types of transactions in the consideration of R&D output of the SMEs.

In the case of non-discrimination of various types of patent applications, I also test with the number of all types of patent applications filed by per SME per year and the number of all types of issued patents.¹⁸²

¹⁸¹ Even though the people or entities other than the patent owners can use the patents when the owners authorize them to do by licenses, subsidiaries to manufacture or mechanize them usually are not through licenses, which are too formal and costly for their registrations. The annual reports of the SMEs rarely disclose any licenses between a parent firm and its subsidiaries.

¹⁸² As the novelty requirement of utility patents was higher, a strategy for patent applicants is to file both the invention patent and the utility model, especially when a firm does not have enough self-confidence to acquire an invention patent or plans to circumvent the relative technologies as earlier as it can. Zhuanli Fa Shishi Xize (专利法实施细则) [The Rules for

2.2. Firm-Level Data in Other Economic Instruments by Government

After learning some private economic instruments by VC/PE investors, recall the importance of economic instruments taken by governments. The data collection includes the amount of tax credits acquired by each SME every year, other general subsidies, and governments' direct funding or grants.

I collect the data of tax credits by categories. In precise, national governments of China authorize tax credits on corporate tax, business tax, capital income tax, land tax and dividends tax. Meanwhile, local governments subsidize firms with their local tax.

Corporate tax in China also is called enterprises income tax. When firms are entitled with “national key high-tech enterprises” or “national key software enterprises”, they can be authorized a corporate tax deduction in 10% to 25% of the enterprises' income.¹⁸³ For particular reasons, some of other enterprises can also be authorized a full corporate tax deduction in particular periods.¹⁸⁴ For example, in order to encourage technology transfers, the government of Shanghai authorizes conditional tax credits on corporate tax for the companies performing technology transfers. In this case, the tax credits for subsidizing the technology transfers by the SMEs of the observations are recorded as an independent category.

For capital income tax, in most of the time, it is used to subsidize export enterprises to avoid

the Implementation of the Patent Law (“the Rules”)] (promulgated by St. Council, 2010) Article 41 China). The Rules for the Implementation of the Patent Law (“the Rules”), Article. An applicant can file applications for both rights at the same day but make a clear claim to inform the SIPO that the technology has a dual application.

¹⁸³ Section 4: “Enterprise Income Tax rate is 25%.”

Section 28: “The key high technology companies supported by the government of country can have a deducted tax rate in 15%.”

Qiye Suodeshui Fa(企业所得税法)[The Law of the People's Republic of China on Enterprise Income Tax] (promulgated by the Standing Comm. Nat'l People's Cong., Mar. 16, 2007, effective Jan 1, 2008) (Lawinforchina) (China).

Guojia Shuiwu Zongju(国家税务总局)[The P.R.C. State Administration of Taxation], *Guanyu Jinyibu Guli Ruanjian Chanye He Jicheng Dianlu Chanye Fazhan Qiye Suodeshui Zhengce de Tongzhi* (关于进一步鼓励软件产业和集成电路产业发展企业所得税政策的通知)[Notice of the State Council on Issuing Enterprises Income Tax Policies on Further Encouraging the Development of the Sof, 2012, accessed June 21, 2016, <http://www.chinatax.gov.cn/n810341/n810765/n812151/n812421/c1083639/content.html>.

¹⁸⁴ Because not all policies are public in China, from some of the annual reports of our sample SMEs, we learn that sometimes governments can particular authorize one firm or few firms with one independent policy. This type of policies was proposed by local government but authorized by the national government.

the situation of replicated taxation or when the enterprises import equipments for production or innovation.¹⁸⁵ However, for my sample SMEs, most of them do not have export businesses. Therefore, for these firms, because some reasons of providing tax credits on capital gains tax can be political policies, such as encouraging technology transactions, the tax credits should induce their behaviors to follow those policies.

Besides the above tax credits, other types of subsidies can also be used to induce behaviors of firms. For example, Chinese governments subsidize patent application fees to encourage SMEs to apply patents. Also, to fill the gap between SMEs and financial sources, the governments provide subsidies for interests of loans. Moreover, the governments subsidize international trade exhibitions by the firms to encourage their exportations and technology communications with foreign firms.

Even though these subsidies were given for reasons of policies, my data collection records the sum of these various types of subsidies other than tax credits because the firms that have been subsidized are free to expend these subsidies. For the same reasons, the tax credits of the sample SMEs are also collected in sum. However, because corporate tax deductions are particular prizes for innovative firms, I independently collect the tax credits on corporate tax in per SME per year.

Overall, I separate subsidies as tax credits or general subsidies. This is because of the significant effects of tax credits on innovation, learned from the literature review. Also, since the subsidies are goal-oriented, they are recorded by particular categories. For example, the subsidies for debt interests and patent application fees are recorded separately from other types of subsidies that are not necessarily related to my research goals.

Moreover, due to the same function as ex post compensation by prizes from the governments, my data collection of general subsidies record monetary prizes from the

¹⁸⁵ Zhonghua Renmin Gonghe Guo Guowu Yuan(中华人民共和国国务院)[The State Council of the P.R.C.], *Guowuyuan Guanyu Tiaozheng Jinkou Shebei Shuishou Zhengce De Tongzhi* (《国务院关于调整进口设备税收政策的通知》)[*Notice of the State Council on Adjusting Tax Policies about Imported Equipment*], 1997, accessed June 21, 2016, <http://www.customs.gov.cn/Default.aspx?TabID=20149&InfoID=110991&ctl=InfoDetail&mid=51150&ContainerSrc=%5BG%5Dnotitle>.

governments separately. Meanwhile, these prizes as non-repayable funds to compensate the SMEs are also combined with other non-retrievable pre-funding by the governments to be recorded as grants.

Besides discussed various types of subsidies by the governments, another type of government supports in capital is government funding. In my data collection, government funding of each SME per year includes the fund of project supporting or lab supporting by the governments. Also, it includes public procurement contract.

Even though public procurement contracts are not free for firms, the payments of these contracts are not only healthy but also always ahead of the performance of the contracts. Meanwhile, public procurement contracts are offered by the governments, so it must be a process in which the behaviors, especially the R&D behaviors, of the firms as the other party to sign them and follow the instruction of the governments and particular policies of the governments.

In addition, since government funding is usually goal-oriented, for my research goals to learn the effects of particular government funding on the innovation related activities, the funds obtained by the SMEs for encouraging their patent applications and making patent strategies are recorded alone.

One issue in the process of collecting the data of funding is on accounting. Because government funding is a type of income for firms, they usually have book cooking to revise the amount of income in the same tax year and delay to disclosure the income in parts or in total to adjust their payments on tax. In the practice of accounting, firms usually disclosure a funding as income when they think that they are doing research under the purpose of the funding. However, it is difficult to relay on their description on the annual reports to discriminate their R&D in different projects in the same year. These projects may have been processing in parallel. Also, there is no a process like auditing to restrict one project to cost the funding of another project, and a firm may spend the pool of funding either from governments or investors on various innovative projects simultaneously.

In my research, in order to learn the direct effects of capital on innovative behaviors of the

SMEs, my data collection clears this type of book cooking. I record the amount of funding that an SME acquired as the amount of capital when it flew into the account of the SME. Even though sometimes a government promised to pay a total amount in front and paid by several times in practice, I record the exact number of the amount of fund that was available to the SMEs every year between 2009 and 2013.

A similar issue of delay also exists in the data collection for subsidies of the SMEs. For this issue, I also only record the subsidies when they in cash are available in the accounts of the SMEs because innovative behaviors can only happen with cash rather than any promises. Comparatively, the deduction on corporate tax happens directly when firms pay tax to the government, so it is recorded as the same year when the corporate tax happened.

Because the tax credits on corporate tax are in a form of deduction, the SMEs usually do not disclose the exact numbers. For a situation like this, I have to calculate them from the income statement of the parent firms of the SMEs by their deduction rates. Even though the SMEs make integrated balance sheets and income statements, it is rare that the subsidiaries of the SMEs are qualified for the deduction.¹⁸⁶ Moreover, recall the difficulties to know the complete subsidiaries of the SMEs. It is even more difficult to have the knowledge of their tax rates. Therefore, there could be a bias that I undervalued the corporate tax deduction. However, compared to the income statement of a parent firm among my sample SMEs to its integrated income statement, I observe that the contribution of income from the subsidiaries of the SMEs is usually less than 10% to be not significant.

3. General Data Descriptions

This section presents the data description and compares the Beijing SMEs and the Shanghai SMEs. T-tests show the R&D investment amount, R&D intensity and patent application activities between the Beijing SMEs and Shanghai SMEs are different in a statistically

¹⁸⁶ Recall the standards of acquiring corporate tax deduction. The firms must be entitled as “national key high-tech enterprises” or “national key software enterprises.”

significant degree, so the SMEs from the two cities are left in two panels to be studied separately.

Generally, the SMEs are distinguished as fourteen categories of industries, including the industries of mine, media and culture, real estate, construction, trade in wholesale and retail, social service, information technology, electronic manufacturing, textile manufacturing, mechanical manufacturing, metal and non-metal manufacturing petroleum and plastic manufacturing, food and beverage manufacturing, pharmaceutical manufacturing, printing manufacturing, and public media and culture. Among those industries, the industry of information technology, electronic manufacturing, mechanical manufacturing, petroleum and plastic manufacturing, and pharmaceutical manufacturing are the five largest groups of SMEs in the samples.

Between 2009 and 2013, the Beijing SMEs on average invested more money in R&D than the Shanghai SMEs, and the ratio of R&D to revenue of Beijing SMEs on average was higher than that of the Shanghai SMEs in a statistically significant degree, shown by t-tests.

In precise, the summary statistics for innovation and government supports in Table 2.1 shows that the Beijing SMEs on average invested ¥41.07 RMB in R&D per year between 2009 and 2013, higher than ¥27.06 million RMB invested by the Shanghai SMEs. The ratio of R&D to employee of the Beijing SMEs on average was 5.71, 1.11 percent higher than that of the Shanghai SMEs.

On average, the Beijing SMEs were funded ¥8.08 million RMB by the governments every year between 2009 and 2013. By contrast, the Shanghai SMEs on average yearly obtained ¥6.59 million RMB from government funding.

In the industry of information technology, the Beijing SMEs were more likely to invest in their R&D activities, and had stronger R&D incentives. The t-test for the number of issued patents does not show a statistical significance between the SMEs from the two cities. In the industry of electronics manufacturing, the size of the Shanghai SMEs on average was larger than the Beijing SMEs. The Shanghai SMEs on average spent more money in R&D and had better

market performance in the form of revenue than the Beijing SMEs.

Moreover, in the industry of mechanical manufacturing, the SMEs from the two cities did not show statistically significant difference in conducting R&D, IP related activities and revenue, but the Shanghai SMEs acquired more government funding during 2009 to 2013.

In the industry of petroleum and plastic manufacturing, the differences in the revenue between the SMEs from Beijing and Shanghai are statistically significant. As regards the results, the Beijing SMEs on average received more compensation from the market. In the industry of pharmaceutical manufacturing, the result of t-test shows that the Shanghai SMEs were statistical significantly larger than the Beijing SMEs. The Shanghai SMEs received more compensation from the market during 2009 to 2013 in the form of revenue. The Beijing SMEs on average invested 3.34 percent more of the revenue on R&D than the Shanghai SMEs did.

The differences in the R&D investment, R&D intensity, the numbers of IPRs obtained by the SMEs, and market performance between the SMEs from Beijing and Shanghai could present the efficiency of the endeavors of the SMEs and the governments when the variances of these factors between the SMEs from the two cities are correlated in a statistically significant degree but not consistent with each other. Therefore, it is important to compare the SMEs from the two cities and their interior and exterior factors relating to innovation.

4. Methodology

4.1. Panel Data Regressions

To explore the research questions in Section III, I firstly develop a panel dataset with the above-presented variables and estimate a series of panel data models for them. Because the sources of the firm-level data are from two different science parks, their empirical results will be compared with each other, combining the local policies in IP and finance. Moreover, beyond the comparison between the two parks, to explore the research questions, the further implications

will apply comparative analysis between their comprehensive pros and cons and the experience of other countries, which have been discussed in the literature review, especially the U.S.'s. This part introduces the design of empirical models to test on the panel data.

The data are coded into three panel datasets for the differences between the two cities where they register and headquarter, and one panel dataset is made by the overall case. The panel datasets are constructed for the 82 and 58 enterprises and their general information in the market of China for five years between 2009 and 2013. Moreover, the same series of estimations are applied to analyzing the three datasets, so the methodology should have 410 and 290 observations separately, and 700 observations in total. However, the difficulties in collecting the data of some variables leave with fewer observations in the estimates.

First, to explore the existence of associations among government funding, prize, corporate tax credits, capital gains tax credits and revenue generated by the SMEs, the two-way effect models are estimated as the followings¹⁸⁷:

$$Revenue_{ift} = \alpha + \beta_1 R\&DI_{it} + \beta_2 PatentIssue_{it} + \beta_3 Fund_{it} + \beta_4 Prize_{it} + \beta_5 Cotaxcredit_{it} + \beta_6 Cataxcredit_{it} + \beta_7 Employee_{it} + \beta_8 Industry_f + Year_t + \mu_i + v_{it} \quad (1)$$

$$Revenue_{ift} = \alpha + \beta_1 R\&DI_{it} + \beta_2 PatentIssue_{it} + \beta_3 UMIssue_{it} + \beta_4 Copyright_{it} + \beta_5 Fund_{it} + \beta_6 Prize_{it} + \beta_7 Cotaxcredit_{it} + \beta_8 Cataxcredit_{it} + \beta_9 Employee_{it} + \beta_{10} Industry_f + Year_t + \mu_i + v_{it} \quad (2)$$

$$Netprofit_{ift} = \alpha + \beta_1 R\&DI_{it} + \beta_2 PatentIssue_{it} + \beta_3 Fund_{it} + \beta_4 Prize_{it} + \beta_5 Cotaxcredit_{it} + \beta_6 Cataxcredit_{it} + \beta_7 Employee_{it} + \beta_8 Industry_f + Year_t + \mu_i + v_{it} \quad (3)$$

$$Netprofit_{ift} = \alpha + \beta_1 R\&DI_{it} + \beta_2 PatentIssue_{it} + \beta_3 UMIssue_{it} + \beta_4 Copyright_{it} + \beta_5 Fund_{it} + \beta_6 Prize_{it} + \beta_7 Cotaxcredit_{it} + \beta_8 Cataxcredit_{it} + \beta_9 Employee_{it} + \beta_{10} Industry_f + Year_t + \mu_i + v_{it} \quad (4)$$

¹⁸⁷ The lagging effects of the explanatory variables and control variables representing innovation-related information are also tested, but the results are not as good as the results with the immediate effects of the variables. Therefore and finally, the models only stay with the immediate effects of the independent variables.

where $i \in I_1 = \{1, \dots, 410\}, I_2 = \{1, \dots, 290\}, I_3 = \{1, \dots, 700\}$, $f \in F = \{1, \dots, 14\}$ and $t \in T = \{2009, \dots, 2013\}$.

i denotes the individual SME. t denotes the year in which the SMEs innovate to apply and acquire patents, and f denotes the industry type. $Year_t$, a dummy variable, is controlled as fixed, denoting the time effect and varying across the five years. μ_i is an individual effect and varies across individual SMEs, but not across time. The remainder disturbance v_{it} denotes the residual varying with individuals and time. In different individuals or levels of time, α denotes the intercept and $\beta_1, \beta_2, \dots, \beta_{10}$ denote the slopes.

Revenue of an SME (*Revenue*) and net profit of the SME (*Netprofit*), the dependent variables, are chosen to capture the performance and competitiveness in the market by the SME. The explanatory variables, *Fund* and *Prize*, are chosen to signify the subsidies or grants released to the SMEs by governments in different stages of their capital demands and for different reasons. *Prize* is coded as ex post compensations when an SME has finished particular compulsory activities for non-profit or realized particular achievements in a year. In contrast, *Fund* is coded as ex ante sponsorship of the innovative projects or the management cost in an SME in a year.

Cotaxcredit and *Cataxcredit* are the other two explanatory variables to signify the two types of tax credits – corporate tax credit and capital gains tax credit. As tax credits, they are also ex post compensations.

R&DI, *PatentIssue*, *UMIssue* and *Copyright* are the control variables and indicate R&D intensity, the number of issued utility patents, issued utility models, and registered software copyrights in an SME in a year. Since the SMEs have limited ability on innovation compared to large firms, most of the SMEs cannot annually acquire issued utility patents from SIPO, which is also proved by the descriptive statistical results. The models also add a dummy variable as a control to distinguish the SMEs acquiring issued utility patents from the SMEs not.

The other variables representing individual firm's characteristics and time are also included as control variables. The number of employees (*Employee*) surrogates for the size of an SME

growing every year. *Industry* is a dummy variable to control for the category of industries where an SME is, so it only varies across individuals, but not across time.

Individual effect, μ_i , is added to account for the unobservable individual heterogeneity in each SME. It accounts for any individual-specific effect that is not included in the models, so the models having it can in principle control for all time-invariant unobserved abilities.

When estimating each of the models, based on the different assumptions about μ_i and the interactions between it and other regressors, estimators should be used differently as the followings:

If the μ_i are assumed to be fixed-parameters to be estimated, it is enough to use ordinary least squares estimators. Formally, an ordinary least squares estimator should be used if the variance of the μ_i is 0, i.e.

$$\sigma_{\mu_i} = 0 \text{ for all } i.$$

This model is referred as Pool Ordinary Least Squares Model (Pooled OLS) for panel datasets.

If the μ_i are assumed to be random parameters but linearly independent of other regressors, the model should use random effects estimators. Formally, a random effects estimator should be used if the variances of the μ_i are not 0, but the covariance between the μ_i and other regressors are 0, i.e.

$$\sigma_{\mu_i} \neq 0 \text{ for some but all } i,$$

$$\text{and } Cov(X_{it}, \mu_i) = 0$$

for all

$$X_{it} \in \{R\&DI_{it}, PatentIssue_{it}, UMIssue_{it}, Copyright_{it}, Fund_{it}, Prize_{it}, Cotaxcredit_{it}, Cataxcredit_{it}, Employee_{it}, Industry_f, Year_t\}, t \in T = \{2009, \dots, 2013\}.$$

This model is referred as Random Effects Model.

If the μ_i are random and not linearly independent of other regressors, the model should use first-difference estimators. Formally, a first-difference estimator should be used if the variance of μ_i and the covariance between μ_i and other regressors can both be not 0, i.e.

$$\sigma_{\mu_i} \neq 0 \text{ for some but all } i,$$

$$\text{and } Cov(X_{it}, \mu_i) \neq 0$$

for some

$$X_{it} \in \{R\&DI_{it}, PatentIssue_{it}, UMIssue_{it}, Copyright_{it}, Fund_{it}, Prize_{it}, Cotaxcredit_{it}, Cataxcredit_{it}, Employee_{it}, Industry_f, Year_t\}, t \in T = \{2009, \dots, 2013\}.$$

This model is referred as Fixed Effects Model.

In order to explore how the government funding, prizes and tax credits are associated with the SMEs' performance represented either by their revenue or net profit through their R&D or the issued IPRs from SIPO and registered software copyrights, besides the above main-effect-only models, product-term models are designed to include the interactions between the explanatory variables and the control variables representing the innovation-relevant information. The two-way effect models are estimated as the followings:

$$\begin{aligned} Revenue_{ift} = & \alpha + \beta_1 R\&DI_{it} + \beta_2 PatentIssue_{it} + \beta_3 Fund_{it} + \beta_4 Prize_{it} + \beta_5 Cotaxcredit_{it} \\ & + \beta_6 Cataxcredit_{it} + \beta_7 Employee_{it} + \beta_8 Industry_f + \beta_9 (INOVATION_{it} \\ & * CAPITAL_{it}) + \beta_{10} (R\&DI_{it} * Cotaxcredit_{it} * PatentIssue_{it}) + Year_t + \mu_i \\ & + v_{it} \quad (5) \end{aligned}$$

$$\begin{aligned} Revenue_{ift} = & \alpha + \beta_1 R\&DI_{it} + \beta_2 PatentIssue_{it} + \beta_3 UMIssue_{it} + \beta_4 Copyright_{it} + \beta_5 Fund_{it} \\ & + \beta_6 Prize_{it} + \beta_7 Cotaxcredit_{it} + \beta_8 Cataxcredit_{it} + \beta_9 Employee_{it} \\ & + \beta_{10} Industry_f + \beta_{11} (INOVATION_{it} * CAPITAL_{it}) + \beta_{12} (R\&DI_{it} \\ & * Cotaxcredit_{it} * PatentIssue_{it}) + Year_t + \mu_i + v_{it} \quad (6) \end{aligned}$$

$$\begin{aligned} Netprofit_{ift} = & \\ & \alpha + \beta_1 R\&DI_{it} + \beta_2 PatentIssue_{it} + \beta_3 Fund_{it} + \beta_4 Prize_{it} + \beta_5 Cotaxcredit_{it} \\ & + \beta_6 Cataxcredit_{it} + \beta_7 Employee_{it} + \beta_8 Industry_f + \beta_9 (INOVATION_{it} \\ & * CAPITAL_{it}) + \beta_{10} (R\&DI_{it} * Cotaxcredit_{it} * PatentIssue_{it}) + Year_t + \mu_i \\ & + v_{it} \quad (7) \end{aligned}$$

$$\begin{aligned}
Netprofit_{ift} = & \\
& \alpha + \beta_1 R\&DI_{it} + \beta_2 PatentIssue_{it} + \beta_3 UMIssue_{it} + \beta_4 Copyright_{it} \\
& + \beta_5 Fund_{it} + \beta_6 Prize_{it} + \beta_7 Cotaxcredit_{it} + \beta_8 Cataxcredit_{it} \\
& + \beta_9 Employee_{it} + \beta_{10} Industry_f + \beta_{11} (INOVATION_{it} * CAPITAL_{it}) \\
& + \beta_{12} (R\&DI_{it} * Cotaxcredit_{it} * PatentIssue_{it}) + Year_t + \mu_i + v_{it} \quad (8)
\end{aligned}$$

where $i \in I_1 = \{1, \dots, 410\}, I_2 = \{1, \dots, 290\}, I_3 = \{1, \dots, 700\}$, $f \in F = \{1, \dots, 14\}$ and $t \in T = \{2009, \dots, 2013\}$.

INOVATION is a matrix including *R&DI*, *PatentIssue* and *UMIssue*. *CAPITAL* is a matrix including *Fund*, *Prize*, *Cotaxcredit* and *Cataxcredit*. Since government funding, subsidies, corporate tax credits and capital gains tax credits are usually authorized to the firms for supporting their innovation, *INOVATION* and *CAPITAL* should be correlated with each other. The two-way interaction term, *INOVATION* * *CAPITAL*, captures their interacted effects on the variation of the dependent variables and helps to clarify the association between the explanatory variables involved in *CAPITAL* and the dependent variables when the intervention of the control variables involved in *INOVATION* is too significant to be ignored or circumvented.

The standards of being qualified to entitle to corporate tax credits take account of both the number of IPRs, especially utility patents, and the ratio of R&D investment to revenue, which is another measure of R&D intensity other than the ratio of R&D investment to employee.¹⁸⁸ Corporate tax credits acquired by an SME must be relevant to its R&D intensity and number of issued utility patents acquired from SIPO, so a three-way interaction term, *R&DI* * *Cotaxcredit* * *PatentIssue*, is also included in the product-term models.

4.2. Difference-in-Difference Specifications

¹⁸⁸ Zhonghua Renmin Gonghe Guo Hexue Jishu Bu[中华人民共和国科学技术部][The Ministry of Science and Tehnology of the P.R.C.], Zhonghua Renmin Gonghe Guo Caizheng Bu[中华人民共和国财政部][The Ministry of Finance of the P.R.C.], and Guojia Shuiwu Zongju[国家税务总局][The P.R.C. State Administration of Taxation], *Gaoxin Jishu Qiyе Rending Guanli Banfa*(高新技术企业认定管理办法)[*Hi-Tech Enterprises Certification Methods*].

There were tax policy changes happening in 2011 and regarding the industry of software and interpreted circuits (IC). Both the corporate tax policy and the capital gains tax policy were amended. To be consistent with the research questions, this part utilizes difference-in-difference (DID) regressions and the regressions adopt 2011 as the intervention year to capture the responses of the policy changes on innovation and market performance by SMEs. In other words, this is to test for the heterogeneous responses across SMEs to the two tax policy changes.

The software or IC firms entitled to corporate tax credits or capital gains tax credits are the treated groups, in which they are entitled to higher rates of tax credits than the other firms.¹⁸⁹ Correspondingly, the other firms are the control groups. The difference-in-difference designs are estimated as the followings:

$$\frac{Revenue}{Employee}_{iftct1} = \alpha + \beta_1 Change_{t1} + \beta_2 Group_c + \beta_3 (Change_{t1} * Group_c) + \beta_4 R\&DI_{it} + \beta_5 PatentIssue_{it} + \beta_6 Fund_{it} + \beta_7 Prize_{it} + \beta_8 Cotaxcredit_{it} + \beta_9 Cataxcredit_{it} + \beta_{10} Employee_{it} + \beta_{11} Industry_f + \beta_{12} FINANCE_{it} + \mu_i + v_{it} \quad (9)$$

$$\frac{Netprofit}{Revenue}_{iftct1} = \alpha + \beta_1 Change_{t1} + \beta_2 Group_c + \beta_3 (Change_{t1} * Group_c) + \beta_4 R\&DI_{it} + \beta_5 PatentIssue_{it} + \beta_6 Fund_{it} + \beta_7 Prize_{it} + \beta_8 Cotaxcredit_{it} + \beta_9 Cataxcredit_{it} + \beta_{10} Employee_{it} + \beta_{11} Industry_f + \beta_{12} FINANCE_{it} + \mu_i + v_{it} \quad (10)$$

$$R\&DI_{iftct1} = \alpha + \beta_1 Change_{t1} + \beta_2 Group_c + \beta_3 (Change_{t1} * Group_c) + \beta_4 R\&DI_{it} + \beta_5 PatentIssue_{it} + \beta_6 Fund_{it} + \beta_7 Prize_{it} + \beta_8 Cotaxcredit_{it} + \beta_9 Cataxcredit_{it} + \beta_{10} Employee_{it} + \beta_{11} Industry_f + \mu_i + v_{it} \quad (11)$$

¹⁸⁹ Guojia Shuiwu Zongju(国家税务总局)[The P.R.C. State Administration of Taxation] and Zhonghua Renmin Gonghe Guo Caizheng Bu(中华人民共和国财政部)[The Ministry of Finance of the P.R.C.], *Guanyu Jinyibu Guli Ruanjian Chanye He Jicheng Dianlu Chanye Fazhan Qiye Suodeshui Zhengce De Tongzhi*[关于进一步鼓励软件产业和集成电路产业发展企业所得税政策的通知][The Notice of Corporate Tax Policy for Further Encouraging the Development of the Industries of Software and Intergrated], 2012.

where $i \in I_1 = \{1, \dots, 410\}, I_2 = \{1, \dots, 290\}, I_3 = \{1, \dots, 700\}, f \in F = \{1, \dots, 14\}, t1 \in T_1 = \{1, 2\}, c \in C = \{1, 2\}$ and $t \in T = \{2009, \dots, 2013\}$.

$\frac{Revenue}{Employee}$ and $\frac{Netprofit}{Revenue}$ are the scaled revenue and surrogate for the ratio of revenue to employee and profit margin, used as financial definitions to represent firm performances. Besides revenue and net profit, the difference-in-difference designs estimate their average degree.

Category fixed effects and the time horizon fixed effects representing the policy change are specified as $Change_{t1}$ and $Group_c$. *FINANCE* is an index taking account of the amount of short-term loans and venture capital shareholder ratio to represent the capital resources that SMEs usually use other than government grants or subsidies.¹⁹⁰ The regressions correct the error structure for heteroskedasticity using the White-Huber estimator. The coefficient of the interaction, β_3 , surrogates for the DID effect. Under the theory, it is predicted a positive value as an estimation result in the model 11.

Following the panel data regressions to test the effects of tax credits on innovation and market performance by SMEs, the interaction between the DID effects and R&D intensity is controlled and the difference-in-difference-in-difference designs are estimated as the followings:

$$\begin{aligned} Revenue_{iftct1} = & \\ & \alpha + \beta_1 Change_{t1} + \beta_2 Group_c + \beta_3 (Change_{t1} * Group_c) + \beta_4 R\&DI_{it} \\ & + \beta_5 (Change_{t1} * R\&DI_{it}) + \beta_6 (Group_c * R\&DI_{it}) + \beta_7 (Change_{t1} * Group_c \\ & * R\&DI_{it}) + \beta_8 PatentIssue_{it} + \beta_9 Cotaxcredit_{it} + \beta_{10} Cataxcredit_{it} \\ & + \beta_{11} Employee_{it} + \beta_{12} Industry_f + v_{it} \quad (12) \end{aligned}$$

$$\begin{aligned} Netprofit_{iftct1} = & \\ & \alpha + \beta_1 Change_{t1} + \beta_2 Group_c + \beta_3 (Change_{t1} * Group_c) + \beta_4 R\&DI_{it} \\ & + \beta_5 (Change_{t1} * R\&DI_{it}) + \beta_6 (Group_c * R\&DI_{it}) + \beta_7 (Change_{t1} * Group_c \\ & * R\&DI_{it}) + \beta_8 PatentIssue_{it} + \beta_9 Cotaxcredit_{it} + \beta_{10} Cataxcredit_{it} \\ & + \beta_{11} Employee_{it} + \beta_{12} \quad (13) \end{aligned}$$

¹⁹⁰ Gilson, "Engineering a Venture Capital Market: Lessons from the American Experience," 57. Also see, Mueller and Reize, *Loan Availability and Investment: Can Innovative Companies Better Cope with Loan Denials?* 1.

where $i \in I_1 = \{1, \dots, 410\}, I_2 = \{1, \dots, 290\}, I_3 = \{1, \dots, 700\}, f \in F = \{1, \dots, 14\}, t_1 \in T_1 = \{1, 2\}, c \in C = \{1, 2\}$ and $t \in T = \{2009, \dots, 2013\}$.

V. Results and Implications

Implication 1: Corporate tax credits have an essential effect on improving the revenue and net profit of SMEs. The strength of the effect on improving net profit and revenue is stronger for the innovation-intensive SMEs.

Sub-Implication 1.1: There is one exception for improving revenue that the effect of corporate tax credits turns to be negative when the innovation-intensive SMEs acquire too many issued utility patents in a year.

Overall, inside each of the estimations of revenue or net profit which are shown in model 5 and model 6 in Table 2.2 and Table 2.3, the coefficients on corporate tax credits are significant and higher than capital gains tax credits and government funding. On average, one more RMB dollar of tax credits in corporate tax contributes to a growth of ¥6.9 RMB in revenue and ¥7.3 RMB in net profit. For the group of Beijing and Shanghai SMEs, the coefficients on corporate tax credits are also consistently significant and positive. Those regression results come to a conclusion that corporate tax credits have an important effect on improving the revenue and net profit of SMEs.

To explore how this encouragement regime works corresponded to innovative activities, I turn to read the product-term models shown in Table 2.4 and Table 2.5. With the overall panel's samples, the product-term models used to predict revenue in Table 2.4 suggest that the coefficients on R&D intensity and corporate tax credits are insignificant. To put it another way, the coefficients on R&D intensity and corporate tax credits do not represent the main effects on

revenue when they are considered separately, as they are traditionally thought to be in the hypothesis for the “main-effect-only” model in Table 2.2. By contrast, the coefficients on their interaction term yield a statistically significant and positive result, suggesting that the presence of an interaction effect. This interaction effect is consistently shown in the estimations for the groups of Beijing’s and Shanghai’s SMEs.

In the overall panel shown by Model 4 in Table 2.4, for every 1 unit that overall R&D intensity increases, the slope of revenue on corporate tax credits is predicted to increase 0.99 units when the number of issued utility patents equals zero. Taking the variation of issued utility patents into account, this positive effect still remains in the scale of issued utility patents in my samples, even when the three-way interaction term among corporate tax credits, R&D intensity and issued utility patents has a negative effect on estimating the growth of revenue.

In the case of Shanghai in Model 3 in Table 2.2, the main-effect-only model cannot reflect the effects of R&D intensity on revenue. Compared to this model, Model 3 in Table 2.4 adds an interaction term between R&D intensity and corporate tax credits, and the interaction term roughly accounts for 6% of the variance in revenue. From the product-term model, even though the coefficient on corporate tax credits turn to negative or not statistically significant, rather than they are traditionally thought of, the coefficient on the interaction term is statistical significant and positive, shown by Model 3 in Table 2.4. Regardless of the statistically insignificant effects of R&D intensity alone on revenue that is reflected by this product-term model, for every 1 unit R&D intensity increases, the slope of revenue on corporate tax credits is predicted to increase 3.97 unit. When R&D intensity is over 2.5, the overall coefficients on corporate tax credits yield a positive result. It suggests that only in innovation-intensive SMEs, corporate tax credits can make significant positive effects on revenue, and the effects can be larger when the R&D intensity of an SME is higher. In fact, there is a threshold that more than 50% of my Shanghai’s samples can achieve.

In the estimations to predict net profit, the effects of corporate tax credits are consistently positive with the three panels. In the case of Beijing, Model 2 in Table 2.4 shows that the

coefficients of the interaction term still imply that the effects of the interaction between R&D intensity and corporate tax credits are statistically significant and positive. For every 1 unit that R&D intensity increases, the slope of revenue on corporate tax credits increase 0.71 units, when issued utility patents is 1.23 (mean of issued utility patent). However, there is a three-way interaction effect, which is negative, the coefficient on the three-way interaction effect suggests that for some SMEs which were with a high R&D intensity (roughly over 11.7 in this case) and acquired more than a particular number of issued utility patents (6 in this case) in a year, corporate tax credits could have negative effects on revenue through the interaction with the two moderator variables. There is a threshold that 95% of the Beijing samples cannot achieve. On the other hand, there is also a negative three-way interaction effects among corporate tax credits, issued patents and R&D intensity, and there is another transition of the positive effects of corporate tax credits on net profit, shown by Model 1 of Table 2.5. For the Beijing SMEs whose R&D intensity was over 0.99 and acquired on average more than 2 issued utility patents in a year, the positive correlation between corporate tax credits and net profit shown by the main-effect-only model in Table 2.3 turns to be negative.

In short, the three panels under main-effect-only models consistently show that the strength of the effect of corporate tax credits on improving net profit is stronger among the innovation-intensive SMEs. The same trend also shows in the estimations to predict revenue in most of the circumstances. However, if we look into the subsidy mechanism corresponding to innovation activities, it is not be always true for a small group of innovation-intensive Beijing SMEs, which acquired utility patents in some amount higher than the average as well, and it is also not always true for over half of the Shanghai SMEs, which are innovation-intensive.

Sub-Implication 1.2: Capital gains tax credits have a positive effect on improving the revenue and net profit of SMEs, but the strength of the effect is weaker compared to corporate tax credits.

In both the estimations of revenue and net profit with the overall panel shown in model 5

and model 6 of Table 2.2 and Table 2.3, the coefficients on capital gains tax credits are statistically significant and positive. On average, one more RMB dollar of capital gains tax credits contributes to a growth of ¥3.13 RMB in revenue and ¥2.49 RMB in net profit when the models hold corporate tax credits as constant at their average level. However, those additional contributions by capital gains tax credits are equal to only half of the positive effects of corporate tax credits.

While the estimations to predict net profit cannot reflect a direct effect of R&D intensity in the overall case, capital gains tax credits can help to explain the relationship between R&D intensity and net profit. The coefficients on interaction term for R&D intensity and capital gains tax credits in Model 3 and Model 4 of Table is statistically significant and positive. In other words, having capital gains tax credits can help the innovation-intensive SMEs to be more capable on improving net profit in the general case. For every ¥10,000 RMB that capital gains tax credits increase, the slope of net profit on R&D intensity is predicted to increase 0.49 units when government funding and corporate tax credits are zero.

For the group of Beijing SMEs, while the estimations cannot show an interaction effect between R&D intensity and capital gains tax credits as the interaction effect between R&D intensity and corporate tax credits shown, the coefficients on capital gains tax credits and the coefficients on corporate tax credits reflect a consistent result with the overall case. That is, capital gains tax credits have a significant positive effect on revenue and net profit, but the effect is weaker than the effect of corporate tax credits. By contrast, for the group of Shanghai SMEs, the estimation results cannot imply a significant effect of capital gains tax credits on either revenue or net profit. Even though the coefficient on capital gains tax credits is statistically significant in Model 3 of Table 2.2, the statistical significance of the effect of capital gains tax credits does not remain after the estimation is improved by holding the significant interaction effect between corporate tax credits and R&D intensity,.

The inconsistency of the effects of capital gains tax credits on revenue and net profit could be caused by a selection bias. Different from the rule of corporate tax credits which refer to the

R&D efforts by the firms, capital gains tax credits are only for the software industry's products and integrated circuit products from the manufacturing in electronics.¹⁹¹ The Shanghai SMEs (n=29) in the industry of manufacturing in electronics are more than the Beijing SMEs (n=15), and t-test shows that the Shanghai SMEs on average invested more in R&D and achieved higher revenue. By contrast, in the software industry, the Beijing SMEs (n=194) are more than the Shanghai SMEs (n=63), and the results of t-test shows that the Beijing SMEs on average invested more in R&D and had larger R&D to revenue ratio. This can be the reason why the overall panel's estimation results about the effects of capital gains tax credits on revenue and net profit are consistent with the Beijing panel's estimations results, but inconsistent with the Shanghai panel's.

Sub-Implication 1.3: When there are no government financing supports, including corporate tax credits, capital gains tax credits, government funding and prizes, the effects of R&D intensity on improving SMEs' revenue are not straightly clear. However, it is clear that improving corporate tax credits can significantly improve the effects of R&D intensity on improving the SMEs' revenue, compared to capital gains tax credits, government funding and prizes.

With the Beijing panel, the interaction-term models in Table 2.4 presents the contribution of covariance between R&D intensity and different types of government financing supports, including corporate tax credits, capital gains tax credits, government funding and prizes on the variation of revenue.

Model 1 and Model 2 show that the coefficients of interaction term between prizes and R&D intensity are statistically significant but negative. Moreover, with the overall panel and the Shanghai panel, the interaction effects cannot explain the variance of revenue in a statistically significant degree.

¹⁹¹ Zhonghua Renmin Gonghe Guo Caizheng Bu(中华人民共和国财政部)[The Ministry of Finance of the P.R.C.] and Guojia Shuiwu Zongju[国家税务总局][The P.R.C. State Administration of Taxation], *Guanyu Guanjian Chanpin Zengzhishui Zhengce De Tongzhi*(关于软件产品增值税政策的通知)[*The Notice About Software Products' Capital Gains Tax Policy*], 2011, accessed June 21, 2016, <http://www.chinatax.gov.cn/n810341/n810765/n812156/n812464/c1186045/content.html>.

By contrast, the coefficients on the interaction term between corporate tax credits and R&D intensity are statistically significant and positive with the three panels. While there is a negative three-way interaction effect among corporate tax credits, R&D intensity and issued patents, this two-way interaction effect stays positive on estimating the growth of revenue when issued utility patents are less than on average 4.54. For every ¥10,000 RMB that corporate tax credits increase, the slope of revenue on R&D intensity increases 1.39 units when there are no prizes and an SME does not acquire issued utility patents. When an SME acquires one utility patent, the slope of revenue on R&D intensity increases 1.22 units for every ¥10,000 RMB that corporate tax credits increase, which is positive but 0.17 units lower than the previous degree.

If I take one-step back to explore the relationship between R&D intensity and revenue, Table 2.2 and Table 2.4 show that the coefficients on R&D intensity are not consistently statistically significant and positive. For the Beijing group, when corporate tax credit is held as constant in its average degree (¥8,187,400 RMB), 1 unit increase in R&D intensity goes with ¥12,780,000 RMB increase in revenue. The effect of R&D intensity is obviously improved comparing to the coefficients on R&D intensity in the estimations that do not control for the interaction effect, shown in Table 2.2. Without taking account the interaction effect, 1 unit increase in R&D intensity only goes along with ¥8,539,000 RMB increase in revenue.

For the Shanghai group, the main-effect-only models of Model 3 and Model 4 in Table 2.2 cannot suggest a statistically significant effect of R&D intensity. After the interaction term between R&D intensity and corporate tax credits is added, even though Model 3 in Table 2.4 reflects that the R&D intensity has a statistically significant and negative effect on the growth of revenue, the interaction effects help to moderate this negative effect of R&D intensity. When corporate tax credits equal zero, 1 unit increase in R&D intensity goes along with ¥19,430,000 RMB decrease in revenue. However, when corporate tax credit is held as constant in its average (¥7,375,300 RMB), 1 unit increase in R&D intensity goes with ¥9,827,815.1 RMB decrease in revenue, which is only half of the decreasing extent in the circumstance of releasing the interaction effect between R&D intensity and corporate tax credits.

In the overall case, the interaction term between R&D and corporate tax credits is also important to explain how the effect of R&D intensity on improving revenue is realized. The statistical significance of the coefficient on R&D intensity does not remain when this interaction term between R&D intensity and issued utility patents and a three-way interaction term among the three factors are added. The coefficients of the three interaction terms are statistical significant, which means that there are both a two-way and a three-way effects. When corporate tax credits and issued utility patents equal zero, it is difficult to explain how R&D intensity has an effect on improving revenue. When corporate tax credits and issued utility patents are constant as their mean (¥7,875,400 RMB, 0.97), 1 unit increase in R&D intensity goes with ¥7,025,565.59 RMB increase in revenue. This effect is only in a slightly lower degree than the effects of R&D intensity by its own, shown by Model 6 in Table 2.2. The difference of the estimation results in Model 6 of Table 2.2 and model 4 of Table 2.4 suggests that the positive effects of R&D intensity on improving the growth of revenue can be importantly through corporate tax credits.

Therefore, in order to improve the SMEs' revenue, especially when the SMEs do not acquire many utility patents from PTO, improving corporate tax credits can effectively improve the R&D intensity's effects on improving revenue. These effects reflect the SMEs' capabilities on the immediate transformation from R&D investment to revenue.

Implication 2: Government funding in the forms of general government funding and public R&D funding is being used by SMEs in their business activities (e.g., investment), especially the weak innovative SMEs, even when net profits do not improve and the government is not able to make more tax income from the funded SMEs. The innovation-intensive SMEs are better at utilizing government funding to improve their net profit, so the government can make more tax income from the funded innovation-intensive SMEs.

General government funding for SMEs is like an investment to incubate SMEs and help

their survival and growth. The “dividends” for the government are the tax payments by the funded SMEs. If the net profit of the funded SMEs is increased, they are able to collect more tax from the SMEs. Besides the goals on improving joint innovation among various entities or on developing particular types of innovation in the favor of public interests, public R&D funding for SMEs also aims to encourage SMEs to conduct R&D activities and help them to survive and grow in the market.

Table 2.3 shows that the coefficients on government funding are always statistically significant with the three panels’ samples in predicting net profit. Moreover, the coefficients are positive in the cases of Beijing and the overall, but negative in Shanghai’s case.

It is reasonable that when an SME acquired a big amount of capital from government as grants or R&D funding, the SME has the power to adjust an appropriate way to run the business with the capital and improve its net profit. Nevertheless, it is difficult to know if this process of promoting net profit involves the effect of R&D by the SMEs. The correlation coefficients of government funding on the increase of R&D expenditure of the SMEs are statistically significant but low. ($r=0.33$ for the group of Beijing, 0.27 for the group of Shanghai, and $r=0.31$ for the overall samples). Meanwhile, the coefficients on R&D intensity are not statistically significant in the case of Beijing and overall, shown by Model 1 and Model 6 in Table 2.3.

The estimations in Table 2.5 suggest that there are interaction effects of government funding and R&D intensity on improving net profit in these two circumstances. The coefficients on the interaction term between government funding and R&D intensity yield statistically significant and positive results. Those results suggest that having higher level of R&D intensity can help the effects of government funding on improving net profit. For every 1 unit R&D intensity increases, the slope of net profit on government funding is predicted to increase 0.598 units (¥5,980 RMB) in the Beijing’s case, and increase 0.496 units (¥4,960 RMB) in the overall case. When R&D intensity equals zero, the coefficients on government funding in the models of Table 2.5 suggest that government funding hardly has a positive effect on improving net profit. Even the worse, the effect of government funding on net profit is negative. For the

Beijing group, when the R&D intensity of an SME can achieve a degree of 6.44 and over, government funding can produce a positive effect on improving net profit. For the overall group, same positive government funding can be released when the R&D intensity of an SME can achieve a degree of 6.37 and over. Actually, there are only more than 25% but less than 50% of the sample SMEs that can achieve this degree of R&D intensity.

For the group of Shanghai, even though the interaction term between R&D intensity and government funding cannot explain the variance of net profit in a statistical significant degree, the coefficients of R&D intensity consistently yield statistical significant and positive results in Model 3 of Table 2.3 and Model 2 of Table 2.5, suggesting that improving R&D intensity has a positive effect on improving net profit, along with the variance of government funding. In other words, when the Shanghai SMEs were using government funding in their business activities, the insensitive innovation ones in Shanghai could come out with higher net profit.

In general, learned from the estimations results, government funding is significantly used by the SMEs in their business activities, especially the weak innovative SMEs, and the innovation-intensive SMEs are better at using government funding to improve their net profit. Therefore, in order to assist SMEs to improve their net profit through government funding, in the forms of either grants or R&D funding, paying the funding to the SMEs and monitoring the progress of their R&D projects should not be the end of the story. The government should consider monitoring the R&D activities in the SMEs and auditing their R&D expenditure to ensure that they are insensitively innovative to be able to improve net profit through the funding.

Implication 3: while the more specified corporate tax policy, which has been amended in 2011, effectively induced the subsidized firms in the software and IC industry to conduct R&D, the broader and more unified capital gains tax policy after 2011 which is to strongly encourage the development of the software and IC industry, are ineffective to promote R&D commercialization and the growth of the SMEs in those two industries.

- The 2011 Amendments of Corporate Tax Policy and Capital Gains Tax Policy in China

In 2011, both the capital gains tax policy and the corporate tax policy have been amended in China. The capital gains tax credits target the firms that sell software and integrated circuit (IC) related products. The scope of the capital gains tax credit is broadened to embedded software products and the rate of the tax credits is unified to the lowest level for all of them.¹⁹² After the entitled firms pay a tax rate of 17% on capital gains tax, their payment that is over a tax rate of 3% on capital gains tax can immediately get returned.

On the side of corporate tax policies, the software and IC firms are entitled to at least 5% lower tax rate on corporate tax than other firms regardless of the entitlement of corporate tax credits for their technical innovation in other industries. The key software firms and the key IC firms are entitled to a corporate tax rate of 10%, 15% lower than the normal corporate tax rate, and 5% lower than the corporate tax rate for the national high-tech firms.¹⁹³

Before 2011, the IC companies that are entitled to corporate tax credits are required the same as the software companies by the government.¹⁹⁴ After 2011, the entitled IC firms are specified based on their R&D investment, size of their R&D department, the process of developing technology and commercializing the technologies and the supply chain.¹⁹⁵

- The Effects of the 2011 Capital Gains Tax Policy Change on the SMEs' Revenue,

¹⁹² Ibid.

¹⁹³ The P.R.C. State Administration of Taxation and The Ministry of Finance of the P.R.C., *Guanyu Jinyibu Guli Ruanjian Chanye He Jicheng Dianlu Chanye Fazhan Qiye Suodeshui Zhengce De Tongzhi*(关于进一步鼓励软件产业和集成电路产业发展企业所得税政策的通知)[*The Notice of Corporate Tax Policy for Further Encouraging the Development of the Industries of Software and Integrated Circuits*].

¹⁹⁴ Guojia Shuiwu Zongju(国家税务总局)[The P.R.C. State Administration of Taxation] and Zhonghua Renmin Gonghe Guo Caizheng Bu(中华人民共和国财政部)[The Ministry of Finance of the P.R.C.], *Guanyu Qiye Suodeshui Ruogan Youhui Zhengce De Tongzhi*(关于企业所得税若干优惠政策的通知)[*The Notice about the Favorable Policies on Corporate Tax Credits*], 2008, accessed June 21, 2016, http://www.tax.sh.gov.cn/pub/xxgk/zcfg/qysds/200803/t20080317_286587.html.

¹⁹⁵ The P.R.C. State Administration of Taxation and The Ministry of Finance of the P.R.C., *Guanyu Jinyibu Guli Ruanjian Chanye He Jicheng Dianlu Chanye Fazhan Qiye Suodeshui Zhengce De Tongzhi*(关于进一步鼓励软件产业和集成电路产业发展企业所得税政策的通知)[*The Notice of Corporate Tax Policy for Further Encouraging the Development of the Industries of Software and Integrated Circuits*].

Revenue/Employee & Profit Margin

Shown by Table 2.5, the difference of the average revenue generated by the SMEs not entitled to capital gains tax policies yields a statistically significant and positive result, suggesting that they improved their revenue in a statistically significant degree before and after 2011; nevertheless, the variance of their average net profit is insignificant shown by Table 2.7. By contrast, the average revenue of the SMEs entitled to capital gains tax credits for their sales in the industry of software and IC industry did not vary in a statistically significant degree after the policy change. Even worse, the difference of the average net profit yields a statistically significant and negative result, suggesting that their average profitability became less after the policy change.

Before 2011, the differences of the average revenue and net profit between the control group and treated group are not statistically significant. It cannot be proven that the degree of revenue and net profit of the two groups is different from each other. However, after the policy change in 2011, the treated group on average generates lower revenue and net profit than the control group in a statistically significant degree. More perspicuously, Figure 2.1 exhibits the variation of the mean of revenue of the two groups before and after the policy changes, suggesting the amended policy obviously impairs the market efficiency of the subsidized software or IC SMEs.

Table 2.6 shows that the subsidized SMEs on average generated ¥157,656,980 RMB less revenue than the non-subsidized SMEs did. Shown in Table 2.7, the subsidized SMEs on average generated ¥48,000,000 RMB less net profit than the non-subsidized SMEs did.

For the overall case, both the diff-in-diff effects shown in the two tables yield statistically significant and negative results, suggesting that the subsidized SMEs on average have a worse ability on generating revenue and net profit compared to the other SMEs after the capital gains tax policy change, the goal of which is to assist the subsidized firms to generate more revenue.

The revenue in Table 2.8, which is also the dependent variable in Table 2.6, is on a scale of

employee and the results are consistent with the regression results in Table 2.6. More clearly, revenue per employee by the treated group became ¥102,200 RMB lower after the policy change, even when the control group's revenue per employee has increased by ¥100,300 RMB. The subsidized software or IC SMEs on capital gains tax credits could not improve their revenue like the other SMEs, the revenue of which was growing in a statistically significant degree.

Table 2.9 shows that the treated group's profit margin (net profit/revenue) was 0.0958 units lower after the policy change. It was 0.0658 units higher than the control group's before the policy change, but the profit margin of the two groups became identical after the policy change. The diff-in-diff effect yields a statistically significant and negative result, suggesting that the capital gains tax policy change results in a negative effect on improving the subsidized software or IC SMEs' profit margin.

The above results have testified Atkinson's theory on designing tax credits to some extent.¹⁹⁶ Atkinson suggests that the government expands R&D tax credits to drive innovation. Instead of stimulating a relocation of R&D activities,¹⁹⁷ likewise, the SMEs may reorganize their business to refer to software products, which is not necessary to generate more revenue or profit compared to their original main business. What is worse that besides the firms being bewildering, a tax policy directing firms to conduct inefficient market activities can even hamper their growth as the other firms in a growing economy.

● The Effect of the 2011 Corporate Tax Policy Change on Revenue and R&D Intensity

The diff-in-diff regression in Table 2.10 tests the intervention by corporate tax policy's change in 2011 for encouraging the Industry of software and ICs. The regression results are reminiscent of the diff-in-diff regression results in Table 2.6 representing the capital gains tax policy's change, even though the treated group and the control group could target different

¹⁹⁶ Atkinson, "Expanding the R&E Tax Credit to Drive Innovation, Competitiveness and Prosperity."

¹⁹⁷ Lolita Paff, "State-Level R&D Tax Credits: A Firm-Level Analysis," *Topics in Economic Analysis and Policy* 5, no. 1 (2005): 1-27.

observations.

Dynamically, Figure 2.1 shows that the means of the subsidized software or IC SMEs before 2011 are higher than the other SMEs', but the means turns to be lower than the other SMEs' after the policy change. When controlling for R&D intensity and other individual characteristics as covariates, the diff-in-diff regression results in Table 2.10 shows that the mean of the revenue of the subsidized software or IC SMEs is ¥130 million RMB, only ¥36.76 million RMB lower than the control group, subsidized for innovating in the industries other than software and IC and probably with a lower rate.

The difference, however, between the means of the treated group and the control group is statistically insignificant before 2011. Therefore, it is hardly to prove the revenue of the two groups of SMEs is different and even to make a meaningful comparison before 2011. Basically, the revenue of the two groups of SMEs was identical before 2011. However, after 2011, the subsidized software or IC SMEs on average generated ¥206,825,230 RMB than the other SMEs. The DID effect also yields a statistically significant and negative result, suggesting that the software or IC SMEs entitling to a higher rate of corporate tax rate generated less revenue than the other SMEs after the revised corporate tax policy sets detailed requests for the IC SMEs.

On the other hand, if the revenue is scaled by employee, the regression result suggests that there is no statistically significant DID effect of the corporate tax policy change. In other words, the corporate tax policy change in 2011 is not necessary to impose worse market performances by the subsidized software or IC SMEs. Their ratio of revenue to employee is always identical with the other SMEs during 2009 to 2013. In this situation, the reason why the policy change has a negative effect on the modulus of revenue of the subsidized software or IC SMEs may imply an industry adjustment of the software and IC industries. As the number of the units of the software or IC SMEs is growing, the size of the units presented by their revenue could be shrinking.

Under this situation, to explore the dynamical effect of the corporate tax policy change in 2011 on promoting R&D by the SMEs, Figure 2.2 shows that the mean of the R&D intensity of

the subsidized software or IC SMEs has become slightly higher than the other SMEs' since 2010, and the difference grew to be obvious after 2011.

Furthermore, the diff-in-diff effect on R&D intensity before and after the corporate tax policy change yields a statistically significant result, shown by Table 2.11. The difference of means of the R&D intensity between the treated group and the control group yields a statistically significant and negative result before 2011. More precisely, the R&D intensity of the subsidized software or IC SMEs on average is 1.34 lower than the other SMEs. After 2011, the difference is statistically significant, but turns out to be positive, suggesting that the R&D intensity of the subsidized software or IC SMEs on average is 1.28 higher than the other SMEs.

Implied by the statistically significant and positive DID effect, even though the other firms have improved their R&D intensity in a statistically significant degree through the policy change, the subsidized software and IC SMEs improved their R&D intensity in statistically significant and higher degree than the other firms.

After the policy change in 2011, the software market in China finally became rational so as to be consistent with the Mann's analysis for the software industry: the Software industry's R&D intensity should be higher than other industries.¹⁹⁸ Meanwhile, it is consistent with the Atkinson's design on tax credit regime.¹⁹⁹ Atkinson suggests that the government expands R&D tax credits and uses unified rate of tax credits to drive innovation. As a result, the firms, especially small firms, can be clearly instructed by the tax policy and acquire the maximum support from the government. For the software or IC SMEs subsidized with the highest tax credit rate on corporate tax compared to the SMEs in the other innovative industries, after the prerequisites for entitling that tax credit rate were further clarified by the amended tax policy in 2011, the software and IC SMEs have materially improved their R&D intensity in an extent that is much stronger than the case of the other firms, even though the other firms have also improved their R&D intensity during the same period.

¹⁹⁸ Ronald J. Mann, "Do Patents Facilitate Financing in the Software Industry?," *Texas Law Review* 83, no. 4 (2005): 961–1030.

¹⁹⁹ Atkinson, "Expanding the R&E Tax Credit to Drive Innovation, Competitiveness and Prosperity."

- Comparison of the Effects of Two Tax Policy Changes on the SMEs

When comparing the two interventions both happening in 2011 together in the regressions in Table 2.12, the model 1 to predict revenue shows that the coefficients of the two interventions are statistically significant and negative, but diff-in-diff effect of the corporate tax policy's change is stronger than diff-in-diff effect of the capital gains tax policy's change. This is reasonable because the intervention of the firms' business operation through corporate tax policy is stronger than the intervention through capital gains tax policy. Capital gains tax policy only requires that the entitled firms shall sell particular products relating to software, rather than controls the whole business chain of the subsidized firms as the corporate tax policy does. Therefore, when the tax policy's intervention fails to improve the subsidized revenue, it is not surprise to see that the negative effect of the corporate tax policy becomes more obvious.

Even though the new corporate tax policy may obviously induce SMEs to conduct R&D in the industry of software and ICs, increasing R&D intensity, however, it is not equal to increasing immediate R&D commercialization. The model 3 in Table 2.12 shows that the treated group used to be more capable to transform R&D into revenue and net profit than the control group before 2011. However, the three-way interaction terms among the intervention time, the dummy group for discriminating the corporate tax credit-entitled SMEs for the innovation in the software and IC industry and the other firms, and the R&D intensity of the SMEs yield a statistically significant and negative results, suggesting that the treated group is less capable to transform their R&D into revenue and net profit after the policy change in 2011. Therefore, even though the treated SMEs on average became more active on conducting R&D after 2011, it is still hard to conclude that the corporate tax policy in 2011 to specify the subsidized IC firms' innovation activities is effective. On the opposite side, it cannot effectively improve the R&D commercialization of the firms in the software and IC industry.

Moreover, the three-way interaction terms, controlling for the difference of R&D intensity

of the capital gains tax credit-entitled SMEs and the others before and after the policy change, do not show a statistically significant output for multi-collinearity, since the treated SMEs' R&D intensity does not affect revenue or net profit differently from the control SMEs. The results are not surprising because the prerequisites of the entitlement only focus on the type of the products sold by the subsidized SMEs, rather than control for their innovation process. However, it is true that this broader and more unified capital gains tax policy after 2011 to strongly encourage the development of the software and IC industry are ineffective to promote immediate R&D commercialization and the growth of the SMEs in those two industries.

It is hardly to find the effect of the policy on the R&D commercialization in the long run, due to the limitation of the five-year period. The further studies can keep tracking the growth of the SMEs to review the efficiency of the tax policy changes in 2011 in promoting the SMEs' R&D commercialization.

VI. Conclusion

The Chinese government supplies multiple categories grants and subsidies to promote innovation by SMEs and their growth. The empirical evidence in this study implies that corporate tax credits and capital gains tax credits relatively have stronger association with revenue and net profit than the other types of both ex ante and ex post monetary supports. To be precise, in the process of directly funding SMEs and their R&D, it is not sufficient to only provide the capital support to the funded SMEs and check the progress of their R&D projects at the milestones. The government also needs to audit the funded SMEs, which could be realized through a third party, beyond simply checking their balance sheets.

In addition, the corporate tax policy designed to encourage R&D activities can induce the SMEs to enhance their R&D intensity. With the firm-level data, the outcomes of R&D, either in the form of revenue or IP application filings, however, are deficiently impacted by this tax policy.

Moreover, one uniform tax policy addressed for different types of technologies, like the amended capital gains tax policy in China, could be rigid. This type of policies not only could not be exploited by SMEs, but also may intervene and even hamper their business development.

Since R&D commercialization and patent commercialization are time consuming and risky, the duration of five years is still too short and some implications with respect to those two R&D outcomes could be rather equivocal. Therefore, it is valuable for further studies to follow up the data and keep studying the innovative behaviors of the SMEs funded or subsidized by the government.

VII. Tables and Figures

Table 2.1. Summary Statistics by Three Panels: Firm Characteristics, Government Subsidies/Funding, IPRs

Variable	Shanghai SMEs					Beijing SMEs					Overall SMEs				
	Mean	Std. Dev.	Min	Max		Mean	Std. Dev.	Min	Max		Mean	Std. Dev.	Min	Max	
R&D	27.06	34.06	0.00	398.49		41.07	54.69	0.00	454.10		35.32	47.80	0.00	454.10	
R&D Intensity (R&D/Employee)	4.104	3.716	0	26.36		5.709	4.265	0	24.84		5.05	4.12	0	26.36	
Revenue	540.34	421.24	38.77	1969.85		483.76	377.32	30.64	1962.38		506.90	396.53	30.64	1969.85	
Net Profit	63.68	174.45	-1752.33	982.26		94.58	163.16	-496.78	2548.78		81.97	168.41	-1752.33	2548.78	
Employee	791.27	658.39	23.00	3627.00		809.42	899.01	34.00	7640.00		801.98	808.56	23.00	7640.00	
Capital Gains Tax Credits	1.07	3.90	0.00	27.43		5.66	13.36	0.00	162.31		3.79	10.81	0.00	162.31	
Corporate Tax Credits	7.38	8.20	0.00	72.12		8.11	10.40	0.00	88.93		7.88	9.55	0.00	88.93	
Fund	6.59	8.78	0.00	63.59		8.08	31.81	0.00	544.07		7.47	25.11	0.00	544.07	
Prize	0.82	1.65	0.00	14.06		0.74	1.57	0.00	13.76		0.78	1.60	0.00	14.06	
#Utility Patent Application Filings	3.06	5.55	0	47.00		6.08	16.51	0	194.00		4.84	13.25	0	194.00	
#Issued Utility Patents	0.61	1.51	0	9.00		1.23	5.08	0	70.00		0.97	4.03	0	70.00	
#Utility Model Application Filings	3.10	6.89	0	73.00		2.74	7.46	0	78.00		2.89	7.23	0	78.00	
#Design Patent Application Filings	2.97	7.01	0	77.00		2.28	7.10	0	100.00		2.56	7.07	0	100.00	
#Issued Design Patents	1.48	6.83	0	68.00		0.81	3.04	0	36.00		1.08	4.96	0	68.00	
#Software Copyright	1.45	7.57	0	102.00		0.72	3.14	0	42.00		1.02	5.41	0	102.00	
	2.22	8.62	0	89.00		3.67	6.94	0	40.00		3.08	7.70	0	89.00	

Note: The unit of the measure of capital amount is ¥1,000,000 RMB.

Table 2.2. Main-Effect-Only Models to Predict Revenue

Panels	Beijing		Shanghai		Overall	
Models	(1)	(2)	(3)	(4)	(5)	(6)
	RE	RE	RE	RE	FE	FE
R&D Intensity (R&D/Employee)	993.1*** (351.6)	853.9** (360.0)	34.05 (428.4)	202.6 (425.4)	816.4*** (282.2)	783.2*** (286.2)
#Issued Utility Patents	-582.4** (227.4)	-498.6** (233.6)	1,556 (1,076)	1,582 (1,089)	-472.7** (214.5)	-433.6* (221.7)
#Issued Utility Model		314.6* (175.1)		-380.2* (207.6)		98.52 (137.7)
#Software Copyright		46.07 (222.2)		-210.9 (248.6)		59.64 (190.0)
Fund	-0.500 (0.402)	-0.440 (0.403)	2.959** (1.458)	3.330** (1.476)	-0.404 (0.387)	-0.392 (0.388)
Prize	26.67*** (6.633)	26.55*** (6.643)	-5.464 (7.480)	-2.675 (7.540)	16.47*** (4.937)	16.44*** (4.947)
Corporate Tax Credits	7.010*** (1.234)	6.962*** (1.234)	10.18*** (2.174)	10.63*** (2.136)	6.972*** (1.072)	6.879*** (1.083)
Capital Gains Tax Credits	2.316* (1.228)	2.515** (1.234)	-6.036 (4.938)	-9.026* (4.875)	3.035** (1.258)	3.134** (1.268)
1.Dummy Issued Patents	6,423** (2,965)	5,236* (3,042)	1,597 (4,144)	3,633 (4,233)	6,238*** (2,203)	5,870*** (2,262)
Constant	-5,386 (12,348)	-4,570 (12,251)	15,995 (24,286)	12,237** (4,841)	11,989*** (2,349)	12,169*** (2,365)
Observations	379	379	263	263	642	642
Number of stock	80	80	55	55	135	135
Tech Fe	Yes	Yes	Yes	No	No	No
Size	Yes	Yes	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.5969	0.5984	0.5097	0.5109	0.549	0.550
Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.						

Table 2.3. Main-Effect-Only Models to Predict Net Profits

Panels	Beijing		Shanghai		Overall	
Models	(1)	(2)	(3)	(4)	(5)	(6)
	Fe	Re	RE	RE	RE	RE
R&D Intensity (R&D/Employee)	-167.4 (300.7)	205.5 (178.1)	570.5* (306.5)	526.9* (303.2)	141.3 (167.3)	223.4 (165.0)
#Issued Utility Patents	-261.6 (184.3)	-334.4** (149.8)	-236.4 (856.4)	-104.9 (836.8)	-302.6* (157.8)	-308.9** (156.2)
#Issued Utility Model		-342.3*** (101.0)		-407.9*** (149.1)		-382.9*** (87.89)
#Software Copyright		-184.1* (104.6)		-44.29 (145.5)		-75.02 (87.08)
Fund	0.790** (0.336)	0.322 (0.226)	-2.939*** (1.128)	-2.839** (1.105)	0.506** (0.254)	0.430* (0.250)
Prize	-0.982 (5.318)	0.990 (4.366)	11.41** (5.580)	12.32** (5.498)	3.432 (3.596)	4.142 (3.561)
Corporate Tax Credits	4.080*** (1.017)	6.837*** (0.701)	12.13*** (1.555)	12.68*** (1.555)	7.159*** (0.677)	7.329*** (0.663)
Catpital Gains Tax Credits	3.317*** (1.084)	2.442*** (0.572)	0.245 (3.044)	0.306 (3.042)	2.583*** (0.661)	2.492*** (0.645)
1. Dummy Issued Patents	2,887 (2,392)	5,757*** (1,953)	-1,460 (3,287)	-582.5 (3,246)	2,131 (1,631)	3,732** (1,647)
Constant	2,539 (2,497)	-1,194 (1,838)	9,525 (9,432)	8,755 (9,629)	-315.1 (1,598)	-685.1 (1,565)
Observations	379	379	262	262	641	641
Number of stock	80	80	55	55	135	135
Tech Fe	No	No	Yes	Yes	No	No
Size	Yes	Yes	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.143	0.1322	0.2358	0.2666	0.1178	0.1335

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 2.4. Product-Term Models to Predict Revenue

Panels	Beijing		Shanghai	Overall
Models	(1)	(2)	(3)	(4)
	RE	RE	RE	FE
R&D Intensity (R&D/Employee)	699.8* (388.8)	770.0** (389.6)	-1,943*** (546.2)	186.5 (306.2)
#Issued Utility Patents	-760.2*** (233.5)	-657.5*** (232.6)	64.42 (1,050)	-775.0*** (226.3)
#Issued Utility Model		-30.58 (178.4)		
#Software Copyright		54.68 (205.8)		
Fund	-0.443 (0.382)	-0.446 (0.367)	2.610* (1.375)	-0.379 (0.374)
Prize	46.15*** (8.961)	45.99*** (8.579)	-1.525 (7.085)	17.78*** (4.789)
Corporate Tax Credits	1.757 (1.906)	-0.220 (1.863)	-9.937** (4.244)	-0.141 (1.707)
Catpital Gains Tax Credits	2.574** (1.189)	2.603** (1.153)	-5.705 (4.675)	2.267* (1.227)
R&D Intensity×Prize	-3.611*** (1.308)	-3.911*** (1.256)		
R&D Intensity×Corporate Tax Credits	0.593*** (0.227)	0.706*** (0.221)	3.967*** (0.735)	0.992*** (0.217)
#Issued Utility Patents×Corporate Tax Credits	1.457*** (0.324)	1.385*** (0.310)		1.363*** (0.309)
R&D Intensity×#Issued Patents×Corporate Tax Credits	-0.127*** (0.0371)	-0.165*** (0.0362)		-0.103*** (0.0350)
#Issued Utility Models×Corporate Tax Credits		0.859*** (0.169)		
1.Dummy Issued Patents	5,907** (2,813)	5,734** (2,763)	3,917 (3,926)	5,338** (2,136)
Constant	-2,423 (12,669)	-2,746 (12,574)	17,850 (23,493)	16,886*** (2,427)
Observations	379	379	263	642
Number of stock	80	80	55	135
Tech Fe	Yes	Yes	Yes	No
Size	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes
R-square	0.6453	0.6784	0.5694	0.583

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 2.5. Product-Term Models to Predict Net Profit

Panels	Beijing	Shanghai	Overall	
Models	(1)	(2)	(3)	(4)
	RE	RE	RE	RE
R&D Intensity (R&D/Employee)	-830.4*** (217.1)	548.2* (300.9)	-509.1** (198.4)	-177.4 (207.8)
#Issued Utility Patents	-364.9** (156.1)	-88.04 (832.0)	-259.6 (168.7)	-275.1* (166.6)
#Issued Utility Model		-954.8*** (281.8)		-312.3*** (86.67)
#Software Copyright		-26.06 (144.0)		-43.95 (85.27)
Fund	-3.849*** (0.782)	-2.767** (1.099)	-3.222*** (0.774)	-3.160*** (0.768)
Prize	-0.337 (4.126)	13.33** (5.476)	2.928 (3.458)	3.609 (3.467)
Corporate Tax Credits	3.132*** (1.108)	10.80*** (1.750)	5.117*** (1.066)	5.878*** (1.068)
Capital Gains Tax Credits	2.439*** (0.548)	0.664 (3.013)	-1.365 (1.499)	-1.449 (1.460)
R&D Intensity×Corporate Tax	0.446*** (0.120)		0.313** (0.131)	0.195 (0.131)
#Issued Utility Patents×	0.737*** (0.225)		0.856*** (0.244)	0.866*** (0.242)
R&D Intensity×#Issued Patents×	-0.0743*** (0.0256)		-0.113*** (0.0291)	-0.108*** (0.0289)
#Issued Utility Models×		0.247** (0.108)		
R&D Intensity×Fund	0.598*** (0.105)		0.511*** (0.103)	0.496*** (0.103)
R&D Intensity×Capital Gains Tax			0.485*** (0.178)	0.490*** (0.172)
1.Dummy Issued Patents	3,325* (1,841)	159.6 (3,243)	897.1 (1,593)	2,365 (1,617)
Constant	5,184*** (1,960)	8,176 (9,481)	3,668** (1,670)	4,032 (4,053)
Observations	379	262	641	641
Number of stock	80	55	135	135
Tech Fe	No	Yes	No	Yes
Size	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes
R-square	0.2524	0.2704	0.1977	0.2063
Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.				

Table 2.6. Revenue Before and After 2011's Capital Gains Tax Policy Change

Subsidized Software/IC Firms			
Time horizon	(Treated)	Other Firms (Control)	difference of means
before 2011	1.30E+04	1.70E+04	-4410.728 (4161.208)
after 2011	1.50E+04	3.00E+04	-15765.698*** (3546.815)
after2011-before2011	1924.632 (4250.256)	13279.6*** (2982.150)	-11354.97*** (5122.681)

Note: the estimation counts the covariates of R&D intensity, the value of corporate tax credits, capital gains tax credits, government funding, prizes employee numbers. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 2.7. Net Profit Before and After 2011's Capital Gains Tax Policy Change

Subsidized Software/IC Firms			
Time horizon	Software/IC Firms	Other Firms (Control)	difference of means
before 2011	6.81E+02	-4.57E+02	1.14E+03 (2002.103)
after 2011	-5.50E+03	-6.77E+02	-4800*** (1707.554)
after2011-before2011	-6200*** (2044.955)	-2.20E+02 (1436.433)	-5947.05** (5122.681)

Note: the estimation counts the covariates of R&D intensity, the value of corporate tax credits, capital gains tax credits, government funding, prizes employee numbers. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 2.8. Revenue per Employee Before and After 2011's Capital Gains Tax Policy Change

Subsidized Software/IC Firms			
Time horizon	(Treated)	Other Firms (Control)	difference of means
before 2011	6.76E+01 (41.502)	9.30E+01 (64.759)	6.936 (5.194)
after 2011	5.76E+01 (30.857)	1.05E+02 (90.849)	-13.313*** (5.017)
after2011-before2011	-10.22*** (3.857)	10.03** (4.525)	-20.25*** (5.053)

Note: the estimation counts the covariates of R&D intensity, the number of issued utility patents, the value of corporate tax credits, capital gains tax credits, employee numbers, VC shareholder ratio, the amount of short-term loans and individual firms' fixed effects. The estimation corrects the error structure for heteroskedasticity using the White-Huber estimator. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 2.9. Profit Margin Before and After 2011's Capital Gains Tax Policy Change

Time horizon	Subsidized		difference of means
	Software/IC Firms	Other Firms (Control)	
before 2011	2.83E-01 (0.407)	2.03E-01 (0.125)	0.0658* -0.039
after 2011	1.88E-01 (0.237)	1.68E-01 (0.262)	-1.81E-02 (0.038)
after2011-before2011	-0.0958** (0.044)	-0.0120 -0.016	-0.0839* -0.049

Note: the estimation counts the covariates of R&D intensity, the number of issued utility patents, the value of corporate tax credits, capital gains tax credits, employee numbers, VC shareholder ratio, the amount of short-term loans and individual firms' fixed effects. The estimation corrects the error structure for heteroskedasticity using the White-Huber estimator. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 2.10. Revenue Before and After 2011's Corporate Tax Policy Change

Time horizon	Subsidized Software/IC Firms		difference of means
	(Treated)	Other Firms (Control)	
before 2011	1.30E+04	1.70E+04	-3675.623 (5137.055)
after 2011	6.27E+03	2.70E+04	-20682.523*** (5163.913)
after2011-before2011	-6.83E+03 (6695.841)	10177.81*** (2699.569)	-17006.9*** (7101.264)

Note: the estimation counts the covariates of R&D intensity, the value of corporate tax credits, capital gains tax credits, government funding, prizes employee numbers. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 2.11. R&D Intensity Before and After 2011's Corporate Tax Policy Change

Time horizon	Subsidized		difference of means
	Software/IC Firms	Other Firms (Control)	
before 2011	4.35E+00	4.78E+00	-1.34** (0.554)
after 2011	8.55E+00	5.72E+00	1.28** (0.613)
after2011-before2011	3.22*** (0.746)	0.617*** (0.264)	2.604*** (0.696)

Note: the estimation counts the covariates of R&D intensity, the number of issued utility patents, the value of corporate tax credits, capital gains tax credits, employee numbers, revenue and individual firms' fixed effects. The estimation corrects the error structure for heteroskedasticity using the White-Huber estimator. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Figure 2.1. Difference of Average Revenue From 2009 to 2013

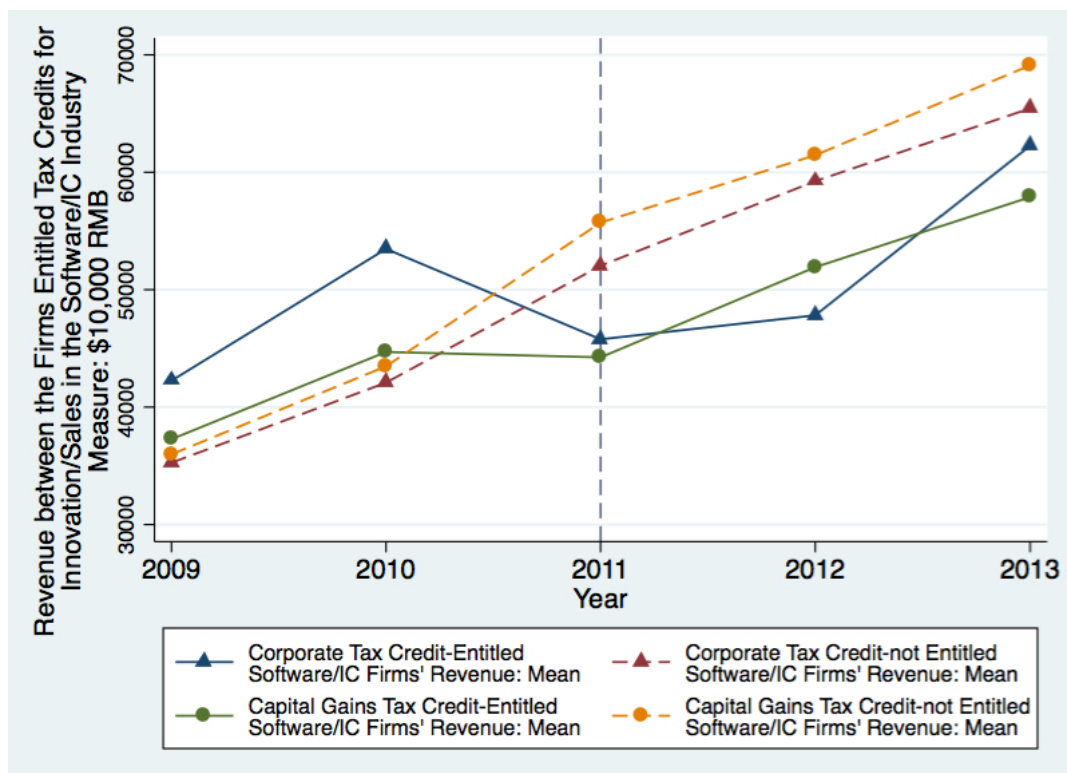


Figure 2.2. Difference of Average R&D Intensity from 2009 to 2013

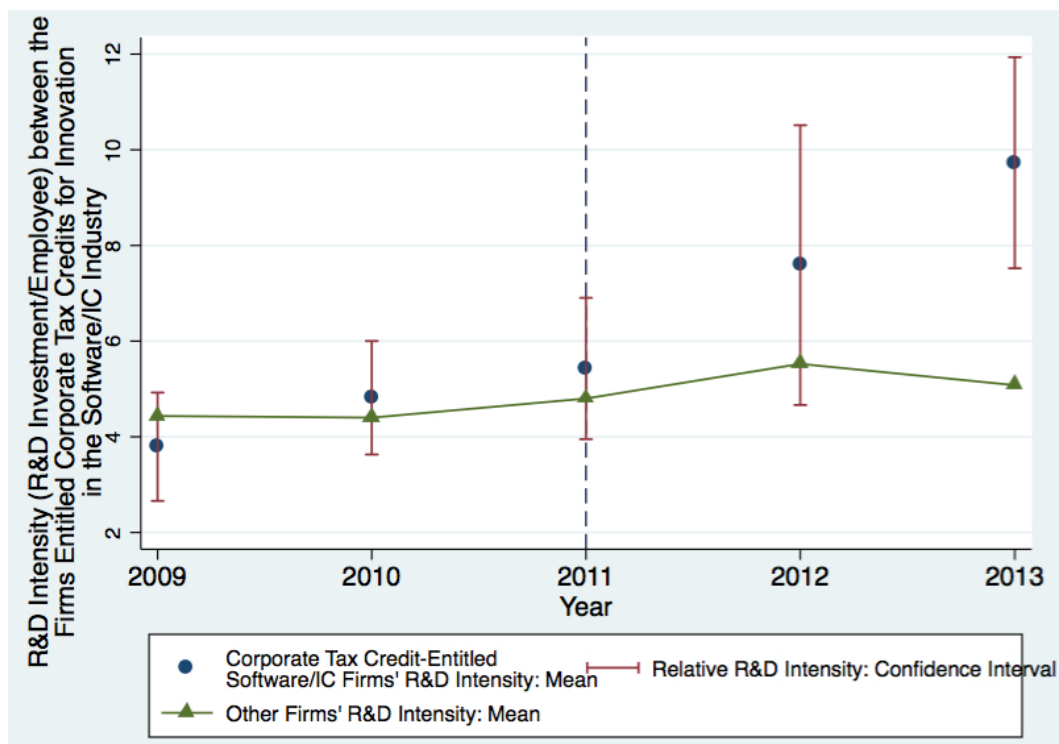


Table 2.12. Diff-in-Diff of the Specification in Revenue or Net Profit before and after 2011

Models	(1) Revenue	(2) Netprofit	(3) Revenue	(4) Netprofit
After 2011#Cataxcredit entitled	-12,147** (4,930)	-5,811** (2,498)	-10,711 (8,943)	6,133 (4,308)
After 2011#Cotaxcredit entitled	-12,556* (6,803)	-2,872 (3,447)	-1,039 (11,741)	17,964*** (5,654)
After 2011#Cataxcredit entitled#R&D Intensity			-	-
After 2011#Cotaxcredit entitled#R&D Intensity			-3,023* (1,806)	-6,441*** (869.8)
After 2011#Cotaxcredit unentitled#R&D Intensity			110.6 (1,421)	2,035*** (684.5)
After 2011#Cotaxcredit unentitled#R&D Intensity			-354.8 (1,293)	-1,597** (622.5)
Cataxcredit entitled compared to others before 2011#R&D Intensity			293.1 (1,248)	1,626*** (601.0)
Corporate Tax Credits#R&D Intensity			2,786* (1,563)	5,081*** (752.8)
Cataxcredit entitled compared to others before 2011	4,449 (4,228)	1,445 (2,142)	2,633 (7,497)	-7,031* (3,610)
Ca&Cotaxcredit unentitled after 2011 compared to before 2011	13,713*** (2,876)	7.821 (1,459)	14,745*** (4,270)	-2,012 (2,058)
Corporate Tax Credits	10.68*** (1.355)	7.375*** (0.686)	10.78*** (1.385)	7.447*** (0.667)
Cotaxcredit entitled compared to others before 2011	-1,926 (4,964)	1,849 (2,515)	-13,547 (8,347)	-19,210*** (4,020)
Catpital Gains Tax Credits	-0.159 (1.284)	2.719*** (0.650)	-0.527 (1.310)	2.142*** (0.631)
Constant	388.2 (6,987)	-1,641 (3,540)	906.9 (7,704)	2,337 (3,710)
Observations	642	641	642	641
Tech Fe	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes
Innovation Fe	Yes	Yes	Yes	Yes
Adj R-squared	0.5018	0.3037	0.5014	0.3705

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

CHAPTER THREE INTELLECTUAL PROPERTY REGIME & SMES' TECHNICAL INNOVATION

I. Literature Review – Intellectual Property

This part reviews the literature on intellectual property. There is much literature theoretically discussing the interaction between intellectual property rights (IPRs) and innovative behaviors or showing the interaction with empirical evidence. This part presents their discussions of the issues on patents and copyrights to show the interaction in various countries, economies, and industries.

Because patent regime is an important and representative form of IP protection for various technologies, Section 1 introduces arguments on the principles of law and economics on patents and general IPRs and their applications. Based on the issues discussed in Section 1, Section 2 specifies the arguments among the scholars exploring an ideal form of protection for software, an important and even extraordinary form of technology compared to other traditional tangible products.

1. Patents

The interaction between patent and innovative activities is complex, especially the innovative activities in developing countries. At the beginning, Section 1.1 presents the literature discussing the reasons why having a patent or IP regime is important to spur innovation. This literature discusses how the rights of patents are valuable to technology developers directly or indirectly, how the content of the technology protected by patents is valuable to other innovators,

and what are the probable negative effects created by the patent or IP regime in the innovation market.

After understanding whether a patent or IP regime can be an effective measure to encourage innovation, Section 1.2 presents the literature that evaluates the strength of the regimes in various countries and argues how governments should structure an effective patent or IP regime to this political goal, especially in developing countries.

1.1. Patents and Innovation

Recall the importance of innovation for economy in general and for small and medium-sized enterprises (SMEs) discussed in the Introduction, some governments of developing countries, such as China, have gradually recognized the role of patents in stimulating innovation in knowledge-based industries.²⁰⁰ However, some scholars in the reviewed literature doubt whether IPRs are capable of stimulating innovation efficiently, even if the IP system is designed to award and provide incentives to undertake innovation.²⁰¹

The traditional standard theory of patents and innovations, drawing on economics, argues that patents are absolutely necessary in order to solve a problem that, without patent protection, might result in there being very little innovation.²⁰² The root of this problem is that it is costly to innovate, but it is inexpensive to copy and market an innovative product. This is because knowledge is nonrival and nonexcludable, so it cannot be used up and cannot be easily defended from imitators.

Without some sort of property interest in the innovation that allows the innovator to protect himself or herself from unauthorized copying, innovators might be discouraged from incurring the costs of innovation. By contrast, patents grant them a monopoly right to exclude others from

²⁰⁰ Li cited the *Report on China's Economic, Social Development Plan (2011)*, which shows that the Chinese government planned to raise their R&D spending on GDP in an obvious level. Li, "Intellectual Property and Innovation: A Case Study of High-Tech Industries in China," 264-265.

²⁰¹ Greenhalgh and Rogers, *Innovation, Intellectual Property, and Economic Growth*, 50.

²⁰² *Ibid.* 32-34.

practicing the technology for a limited time.²⁰³

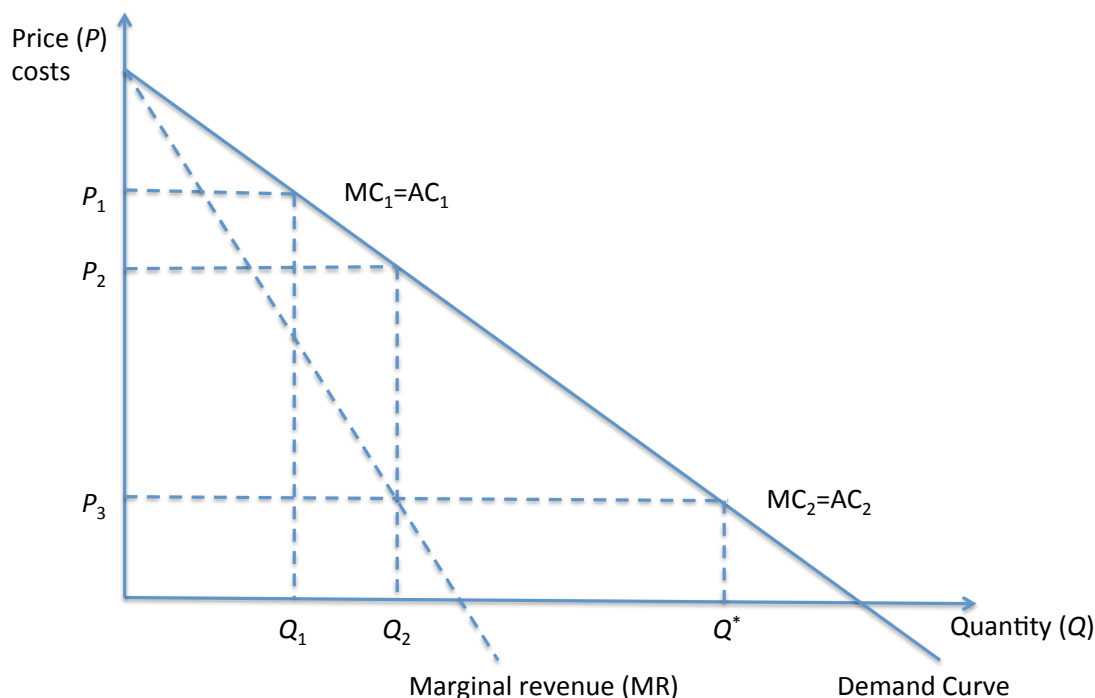


Figure 3.1. Product or process innovation with patent

Under the assumption of a perfectly competitive market, looking at Figure 3.1, economists believe that the product innovators can produce Q^* (quantity) at MC_2 (marginal cost) = AC_2 (average cost), but sell at P_2 (price) to acquire the maximum profits, as allowed by their patents for the product innovation.²⁰⁴ Without the monopoly from patents, at the beginning, they can only sell at P_3 .²⁰⁵ Alternatively, protecting the innovation by trade secrets, the innovators can also sell at P_3 , lower than the monopoly price P_2 .²⁰⁶

To use the same figure to explain how process innovators are awarded for their patents from the market, economists assume that they produce and sell at P_1 before the process innovation that

²⁰³ The duration of patent protection is typically twenty years from the date when the patent applicants filed the patent application. See 35 U.S.C. section 154(a). Also see, the TRIPs, Article 33.

²⁰⁴ Profit maximization occurs at MR (marginal revenue) = MC .

²⁰⁵ Ibid. 9-15.

²⁰⁶ Denicolò and Franzoni, "Weak Intellectual Property Rights, Research Spill-Over and the Incentive to Innovate." 118

reduces their costs of production.²⁰⁷ $P_1 = MC_1 = AC_1$ is their lowest AC at that stage. After doing process innovation and acquiring patents on it, a firm can produce at $MC_2 = AC_2$ and sell the product at P_2 in the market or license to other producers at $P_2 - AC_2$ to obtain the most profits from the innovation. When the patents, and thus the monopoly, expire, the price falls to P_3 .

Hence, if the innovator knows that he or she has a protectable interest in his or her invention, then, it makes sense to invest resources (and incur opportunity costs) in trying to innovate. If the innovation results in and receives patent protection, then the innovator can, through licensing or excludable sales, realize revenues that might provide a handsome reward for his or her efforts. Under the protection of patents, they can exclusively use the nonrival goods with the returns above the marginal cost of its production, which should create the incentives for continuous innovation. Hall and Ham thus conclude that this same underlying principle exists in the patent systems in all countries, no matter how their patent laws are different.²⁰⁸

Moreover, this theoretical argument in favor of patent protection has additional refinements and is largely borne out by studies from the side of empirical studies. Bound et al. search around a panel of U.S. public firms from 1972 through 1978 and their samples show that the innovative firms, especially the small size ones, also file patents.²⁰⁹ However, unfortunately, further supportive empirical evidence is hard to develop. For example, an empirical study of 95 U.S. firms over years from 1979-1995 in the industry of semiconductor by Ziedonis and Hall cannot prove that the increase of patenting by the firms is not the result of the award appreciated by their R&D from the market, although the study suggests that the strengthening of the U.S. patent rights can provide incentives for firms to patent.²¹⁰

²⁰⁷ For example, based on the Arrow's theory on that the competitiveness brought by patents can effectively stimulate innovation in an efficient market, Greenhalgh and Rogers explain the rational with a figure like this in their book. Greenhalgh and Rogers, *Innovation, Intellectual Property, and Economic Growth*, 32-34..

²⁰⁸ Bronwyn H Hall and Marie Ham, *The Patent Paradox Revisited: Determinants of Patenting in the US Semiconductor Industry, 1980-94, NBER Patent System and Innovation*, 1999, 5.

²⁰⁹ John Bound et al., "Who Does R&D and Who Patents?," in *National Bureau of Economic Research*, 1984, 51.

²¹⁰ Ziedonis and Hall, "The Effects of Strengthening Patent Rights on Firms Engaged in Cumulative Innovation: Insights from the Semiconductor Industry." 171. Also see, Hall and Ziedonis, "The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995." Both studies use the same database, and the latter one controls a narrower time period, from 1982 to 1992 but comes out with a consistent result with the former one.

Hence, there are more theoretically normative analyses both in general circumstances and in specific industries holding positive perspectives on the effects of the patent protection on innovation. For example, an extended theoretical study of green technologies by Reichman, Rai, Newell, and Wiener supports IPRs in creating positive incentives for innovation and helping a firm or individual in any stage of its R&D.²¹¹

Moreover, due to its relationship linked with market, Maskus and Okediji consider a patent system as a mechanism designed to foster dynamic competition through improvement of inventions and downstream innovation.²¹² In the view point of Lemley, this mechanism allowing selling or exclusively licensing patents can improve social economic efficiency when the commercialization of inventions is in the hands of those who are in a better market position.²¹³ Also, Li believes that the IP system is created to remedy the market failure of “free-rider” problem and to foster innovation.²¹⁴

Hence, Burk and Lemley conclude that “patent law is our primary policy tool to promote innovation, encourage the development of new technologies, and increase the fund of human knowledge.”²¹⁵ However, there is considerable diversity of the situations and levels of the encouragement.

On one hand, Roffe and Spennemann conclude that stronger exclusive rights of IP can produce higher levels of creativity and innovation.²¹⁶ Based on their empirical study, Ziedonis and Hall agree with this argument because they imply that the expected benefits from patents by the firms outweighed their R&D costs on the patents when U.S. patent rights were

²¹¹ Reichman et al., “Intellectual Property and Alternatives: Strategies for Green Innovation,” 361.

²¹² Maskus and Okediji, “Legal and Economic Perspectives on International Technology Transfer in Environmentally Sound Technologies,” 397.

²¹³ Mark A Lemley, “Should Patent Infringement Require Proof of Copying,” *Mich. L. Rev.* 105 (2007): 1532.

²¹⁴ Li, “Intellectual Property and Innovation: A Case Study of High-Tech Industries in China,” 268.

²¹⁵ Dan L Burk and Mark a Lemley, “Policy Levers in Patent Law,” *Virginia Law Review* 89, no. 1573 (2003).

²¹⁶ Pedro Roffe and Christoph Spennemann, “Preferential Trade Agreements and Intellectual Property Rights,” in *Intellectual Property Rights: Legal and Economic Challenges for Development*, ed. Mario Cimoli et al. (Oxford University Press, 2014), 459.

strengthened.²¹⁷

On the other hand, Glass realizes how weak IPR protection can compensate the cost of R&D of firms so as to encourage them to expand innovations, but he also sees that strong IP rights protection makes R&D more difficult because their R&D process involves higher costs created by the strong IPR protection regime.²¹⁸ Moreover, a cross-national study done by Park shows that IPRs stimulate R&D investment indirectly.²¹⁹

The positive effects of patent systems to spur innovation, however, may not be proper to be directly applied to all places and industries. Li thinks that pro-innovation patent systems work positively in industrialized countries, but is hesitant about their significance or relevance in promoting innovation in developing countries.²²⁰ Scotchmer believes that IP can encourage development of new products, and he also agrees that more innovative countries will favor more extensive IP rights than less innovative countries. For example, even if R&D activities by industry in the E.U. and the U.S. are far from full participation, their R&D activities are still more active on some levels than those in certain developing countries of Latin America.²²¹

Because of the trend of globalization, Stiglitz believes that IP plays an important role in stimulating innovation, especially for developing countries, so their markets can flourish to induce more competition as the trigger of doing innovation.²²² While his position here is positive, he and Dosi update their view to believing that strong IPRs may be harmful for innovation.²²³ Strong IPR would not only impede followers, but the incentives of innovation created by

²¹⁷ Ziedonis and Hall, "The Effects of Strengthening Patent Rights on Firms Engaged in Cumulative Innovation: Insights from the Semiconductor Industry," 74.

²¹⁸ Amy Jocelyn Glass, "Costly R&D and Intellectual Property Rights Protection," *International Journal of Technology Management* 19, no. 1-2 (2000): 192, accessed June 21, 2016, <http://econweb.tamu.edu/aglass/cos.pdf>.

²¹⁹ Walter G. Park, *Do Intellectual Property Rights Stimulate R&D and Productivity Growth? Evidence from Cross-National and Manufacturing Industries Data*, 2005, <https://www.leadership.american.edu/cas/faculty/wgpark/upload/09-induscan.pdf>. 40

²²⁰ Li, "Intellectual Property and Innovation: A Case Study of High-Tech Industries in China," 281-2.

²²¹ Scotchmer, "The Political Economy of Intellectual Property Treaties." 415, 417-418. In 2002, only 56% R&D spending in the E.U. was by industry, and 68% in the U.S., which are considerable departures from 100%.

²²² Olwan, *Intellectual Property and Development: Theory and Practice*, 117.

²²³ Dosi and Stiglitz, "The Role of IPRs in the Development Process, with Some Lessons from Developed Countries: An Introduction," 5, 9, 32.

monopolies could also be small. Hence, they predict that IPRs are not the best approach to encourage innovation, or could even be the worst sometimes because patent system can only provide compensation when R&D is successful. In a bigger map of the market, based on the result of an empirical study about Germany innovators, Blind et al. believe that patents can impede competition because patent owners are strategically use patents for offensive blocking their competitors.²²⁴

Furthermore, Boehm and Silberston point out that the political goal of stimulating innovation just could not be properly reached by the patent regime created and designed specifically for that goal (in particular industries).²²⁵ Maskus believes that exclusive rights of patent owners under strong protection may impede transferring technologies to particular markets, such as in developing countries, and lack of attraction of these markets may not be caused by weak protection of IP because of lacking evidence to support a positive tendency of foreign direct investment (FDI) and technology transferring even in certain countries with strong patent protection.²²⁶ Heller and Eisenberg point out that patents for upstream products of the biomedical industry may deter innovation because of anticommons issue made by their abuse of patents.²²⁷

Besides the anticommons problem, Shapiro criticizes the patent regime for its overreward because of his worries about the priors of the technologies of patents and its lack of meaning of instruction through the poor patent disclosure of patents, so the patent regime may kill many joint-inventions.²²⁸ Denicolo and Franzoni only support rewarding the first inventor by patents because they believe that rewarding late inventors may reduce the incentive scheme and cause duplicate social cost on R&D, even though they admit that patent rights are incentives for

²²⁴ Knut Blind et al., "Motives to Patent: Empirical Evidence from Germany," *Research Policy* 35, no. 5 (2006): 666, 671, accessed June 21, 2016, <http://linkinghub.elsevier.com/retrieve/pii/S0048733306000448>.

²²⁵ Klaus Boehm and Aubrey Silberston, *The British Patent System*, vol. 123 (Cambridge University Press, 1967), 123-124.

²²⁶ Keith E. Maskus, "Transfer of Technology and Technological Capacity Building," n.d. (Sep 03, 1997), 2, 6-7.

²²⁷ M a Heller and R S Eisenberg, "Can Patents Deter Innovation? The Anticommons in Biomedical Research.," *Science (New York, N.Y.)* 280, no. May (1998): 198.

²²⁸ Shapiro, "Prior User Rights," 95.

innovation and the first-inventor rule has been abandoned in the U.S. law.²²⁹

Moreover, an empirical study by Levin and other scholars, based on a survey around 650 firms from 35 industries in the U.S., shows that many industries as a whole, not just the patent owners, think of patents as ineffective and that they have high duplication costs.²³⁰ Another empirical study, of the 1988 patent reforms in Japan, by Sakakibara and Branstetter cannot prove that “pro-patent” public policies would induce additional innovation.²³¹ Chang observes this trend on the international level and concludes that private intellectual property could not necessarily be the incentive for innovative activities.²³²

The 2008 Berkeley Patent Survey also shows a similar conclusion on startups.²³³ Graham et al. surveyed around 1,332 early-stage technology firms, which have been funded at most ten years, and they conclude that these technology startups acquire weak incentives for significant innovative activities, even though these firms are more likely to file for patents than the scholars believed.²³⁴

Kortum and Lerner’s empirical study shows that the increase in patenting in the 1980s and 1990s in the U.S. was driven by the innovative activities to link research productivity and research efforts, but those innovative activities are on innovative management, not on the amount of R&D.²³⁵ They suspect a rationale that the growth of innovation strengthens IP regime rather than the IP regime encouraging innovation.

In short, another interpretation of the above arguments is that the effectiveness of patents on

²²⁹ Vincenzo Denicolo and Luigi A. Franzoni, “On the Winner-Take-All Principle in Innovation Races,” *Journal of the European Economic Association* 8, no. September 2010 (2010): 1133–58, accessed June 21, 2016, <http://arxiv.org/abs/math/9412202>. 1134–1135.

²³⁰ Richard C Levin et al., “Appropriating the Returns from Industrial Research and Development,” *Brooking Papers on Economic Activities* 3 (1987): 811.

²³¹ Mariko Sakakibara and Lee Branstetter, “Do Stronger Patents Induce More Innovation? Evidence from the 1988 Japanese Patent Law Reforms,” *The RAND Journal of Economics* 32 (2001): 98.

²³² Ha-Joon Chang, “Intellectual Property Rights and Economic Development: Historical Lessons and Emerging Issues,” *Journal of Human Development* 2, no. 2 (2001): 294.

²³³ Sjh Graham and Rp Merges, “High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey,” *Berkeley Techn. Law J.* 24 (2009): 1255.

²³⁴ Ibid. 1285–1287.

²³⁵ Kortum and Lerner, “Stronger Protection or Technological Revolution: What Is Behind the Recent Surge in Patenting?” 27,33.

stimulating R&D fluctuates among different economies and industries. Burk and Lemley believe that the patent statute is merely demanded by the industry-specific nature of innovation.²³⁶ Li agrees that patents are equally important or efficient in innovation for hardware companies, such as medical hardware and IT hardware, but are less important for software firms, so he encourages applying different patent laws for different industries.²³⁷

He, however, concludes that the variance of importance of IP to innovation among different industries could be different among different countries, and the innovation in the industries in China should be the one having positive relationship with IP.²³⁸ Olwen also sustains that IP has a positive influence on domestic innovation in certain developing countries, but not in all countries with IP alone. In order to clarify, he suggests measuring both IP law and the enforcement of IP for producing better empirical results than the results of some previous studies.²³⁹

1.2. Construction of patent environment to stimulate innovation

In the times and the environment of globalization, 188 countries are members of WIPO (the World Intellectual Property Organization).²⁴⁰ They provide exclusive rights of protection for IP, either stronger or weaker. In this world where it is inevitable to have IPRs protection, my meaningful discussion should focus on how the IPR regime is built to stimulate innovation efficiently rather than on whether we should have an IPR regime, especially at the time when many countries are criticizing China for lacking the strength of IPR protection²⁴¹.

With the knowledge that IPR is necessary for the development of a country, Hu and Jaffe conclude that lack of innovation in developing countries might not be caused by weak IPR but by

²³⁶ Burk and Lemley, "Policy Levers in Patent Law," 226.

²³⁷ Li, "Intellectual Property and Innovation: A Case Study of High-Tech Industries in China," 275, 277.

²³⁸ Ibid. 301-4.

²³⁹ Olwan, *Intellectual Property and Development: Theory and Practice*, 134-136.

²⁴⁰ WIPO statistic.

²⁴¹ Li, "Intellectual Property and Innovation: A Case Study of High-Tech Industries in China," 304.

their limited buying power on the market.²⁴² However, while they understand that the extension of strong IPR to all countries is unlikely globally efficient because harmonization based on the model of the U.S. IP regime only favors developed countries, they also emphasize that if IPR protection in developing countries is too weak, their IP system will inhibit innovation because of too little compensation.

For the technology-follower countries, the increased dynamic competition through IPRs can promote technology transfer helping IPRs to spur the growth of economy indirectly, so Maskus, Dougherty and Mertha encourage strengthening IPRs in developing countries, like China. Meanwhile, in the case study of Lebanon, Maskus reminds that stronger IPRs expand leading foreign technologies that feed Lebanon's production and technology development in a dynamic process of spillover or competition.²⁴³ However, Correa believes that the weak IP regime of developing countries can favor local firms.²⁴⁴ They can develop minor innovations under liability rule or utility models to optimize social benefits.

In the interior of the regime, Li thinks that developing countries should learn from the broadest subject matter protection in the U.S. model of IP regime, which makes it successful.²⁴⁵ However, Cimoli, Dosi, Mazzoleni and Sampat think that the extension of patentable subject matters has negative potential effects on future rate of innovation.²⁴⁶ While Sakakibara and Branstetter examined the expansion of patent scope in Japanese patent regime in 1988 with empirical evidence and expected a positive reflection of R&D expenditure or patent filings for

²⁴² Albert G.Z. Hu and Adam B. Jaffe, "Lessons from the Economics Literature on the Likely Consequences of International Harmonization of IPR Protection," in *Intellectual Property Rights: Legal and Economic Challenges for Development*, ed. Mario Cimoli et al. (Oxford University Press, 2014), 107.

²⁴³ Keith E. Maskus, "Strengthening Intellectual Property Rights in Lebanon," in *Intellectual Property and Development: Lessons from Recent Economic Research*, ed. Carsten Fink and Keith E. Maskus (The World Bank and Oxford University Press, 2005), 266.

²⁴⁴ Carlos M. Correa, "Multilateral Agreements and Policy Opportunities," in *Intellectual Property Rights: Legal and Economic Challenges for Development*, ed. Mario Cimoli et al., 2014, 420-421.

²⁴⁵ Li, "Intellectual Property and Innovation: A Case Study of High-Tech Industries in China," 278.

²⁴⁶ Mario Cimoli et al., "Innovation, Technical Change, and Patents in the Development Process: A Long-Term View," in *Intellectual Property Rights: Legal and Economic Challenges for Development*, ed. Mario Cimoli et al. (Oxford University Press, 2014), 79.

this reform, the result does not provide evidence to support this assumption.²⁴⁷

Through a simulation of the dynamic effects of IP protection, Panagopoulos and Park conclude that sustainable innovations and the strength of IP protection have an inverted U-shape relationship, so takeover agreements between incumbents and startups can motivate startups' innovation only if the IP protection is appropriate but not excessive.²⁴⁸

About the diversity of industries, Denicolo and Franzoni conclude that weak IPRs are required for the development of few industries, but not all. For example, strong IPRs are appropriate in the pharmaceutical section but not in the software and semiconductor industries, such as in Silicon Valley, because of their study result showing that "large R&D spill-overs favor non-exclusive protection."²⁴⁹ Also, Maskus, Dougherty and Mertha suggest expanding the effects of spillover of state owned enterprises, the strongest innovative subjectives in China, through enhancing IPR protection.²⁵⁰

In the pharmaceutical industry, which demands basic science to develop new products, Coriat and Orsenigo prove an inverted U-shape relationship to describe the relationship between pharmaceutical innovations and pharmaceutical patent laws, presenting that strong patent protection harms innovation, especially in developing countries.²⁵¹ Also, while Ganslandt, Maskus and Wong agree that IPRs can provide compensation of the drug and vaccine research, they predict that strong IPRs in poor countries cause inefficiency through high prices to compensate innovators from rich countries but dull the incentives of local innovators.²⁵²

²⁴⁷ Sakakibara and Branstetter, "Do Stronger Patents Induce More Innovation? Evidence from the 1988 Japanese Patent Law Reforms," 30-33.

²⁴⁸ Andreas Panagopoulos and In-Uck Park, *Patent Protection, Takeovers, and Startup Innovation: A Dynamic Approach*, 2004, 19-20, accessed June 21, 2016, <http://www.bristol.ac.uk/media-library/sites/cmpo/migrated/documents/wp201.pdf>.

²⁴⁹ Denicolò and Franzoni, "Weak Intellectual Property Rights, Research Spill-Over and the Incentive to Innovate," 115-116.

²⁵⁰ Keith E. Maskus, Sean M. Dougherty, and Andrew Mertha, "Intellectual Property Rights and Economic Development in China," in *Intellectual Property and Development: Lessons from Recent Economic Research*, ed. Carsten Fink and Keith E. Maskus (The World Bank and Oxford University Press, 2005), 325.

²⁵¹ Coriat and Orsenigo, "IPRs, Public Health and the Pharmaceutical Industry: Issues in the Post-2005 TRIPS Agenda," 234.

²⁵² Mattias Ganslandt, Keith E. Maskus, and Eina V. Wong, "Developing and Distributing Essential Medicines to Poor Countries: The Defend Proposal," in *Intellectual Property and Development: Lessons from Recent Economic Research*, ed. Carsten Fink and Keith E. Maskus (The World Bank and Oxford University Press, 2005), 779-95.

The empirical study done by Fink about Indian pharmaceutical supports that effective competition can restrain the excessive price of on-patent drugs. While developing countries will move toward stronger patent rights under globalization, he reminds the Indian government to deal out measures, such as to grant compulsory licenses, restraining the price of exclusive rights of patents.²⁵³ In the case of China, Li realizes that while patent filings in its biotech and pharmaceutical sectors are significantly increasing in recent years, the quantity and quality of these patent applications are still relatively lower than those in developed countries.²⁵⁴

In the manufacturing industry, Fink's empirical study shows that stronger IPRs in Germany facilitate inventions and patent activities.²⁵⁵ In agriculture, while patents are available and can be effectively used in its areas, such as agricultural machinery, Nuvolari and Tartari see many successful strategies that do not rely on formalized IPRs, and conclude that stronger IP protection for plant varieties may degenerate anticommons tragedy.²⁵⁶ Swanson and Goeschl believe that the nature of the gap of the innovative capability in agriculture between developing countries and developed countries is not their input on innovation, but the efficiency that is higher in developed countries.²⁵⁷ Thus, their prediction model for agricultural yields shows how strong IPR regime generates greater rate of innovation in developed countries, but their data of the impact of stronger IPR in China shows a reduced rate of positive effect on its growth of innovation.

Therefore, when understanding these arguments, Cimoli et al. conclude that to structure a better IPR regime which fosters more innovation and more access to knowledge in developing

²⁵³ Carsten Fink, "Patent Protection, Transnational Corporations, and Market Structure: A Simulation Study of the Indian Pharmaceutical Industry," in *Intellectual Property and Development: Lessons from Recent Economic Research*, ed. Carsten Fink and Keith E. Maskus (The World Bank and Oxford University Press, 2005), 245-251.

²⁵⁴ Li, "Intellectual Property and Innovation: A Case Study of High-Tech Industries in China," 287.

²⁵⁵ Carsten Fink, "Intellectual Property Rights and U.S. and German International Transactions in Manufacturing Industries," in *Intellectual Property and Development: Lessons from Recent Economic Research*, ed. Carsten Fink and Keith E. Maskus (The World Bank and Oxford University Press, 2005), 103-104.

²⁵⁶ Nuvolari and Tartari, "Innovation, Appropriability and Productivity Growth in Agriculture: A Broad Historical Viewpoint," 258.

²⁵⁷ Timothy Swanson and Timo Goeschl, "The Distributive Impact of Intellectual Property Regime: A Report from the 'Natural Experiment' of the Green Revolution," in *Intellectual Property Rights: Legal and Economic Challenges for Development*, ed. Mario Cimoli et al. (Oxford University Press, 2014), 272, 280, 281.

countries is an issue of its appropriate design rather than merely strengthening or weakening it.²⁵⁸ Meanwhile, Ziedonis reminds that it is not enough just to structure a “pro-patent” regime. In her empirical study investigating 72 U.S. semiconductor firms from 1980 to 1994, the data cannot prove how this regime encourages R&D, even though there is a trend showing that this regime does effectively improve patenting behaviors of innovators.²⁵⁹

Broader than an idea controlling the IPR regime alone or solely relying on traditional theories, such as static competition, industry-level analysis, and single-invention innovation model, Teece suggests that it is vital for legislatures and policymakers to count dynamic competition and the dynamic performance of firms independently or under corporation in the ecosystem of the market.²⁶⁰

2. IPRs for Software

It is inevitable to discuss software in the issues of innovation because incredible innovations serve the information intensive industry and software-related industries.²⁶¹

“It is now commonplace that an application of a law of nature or mathematical formula to a known structure or process may well be deserving of patent protection,” so software could be patentable in the U.S.²⁶² In a broader scope, TRIPS also supports the patentability of software.²⁶³

One software product may need to encompass hundreds of technologies of others, probably

²⁵⁸ Mario Cimoli et al., “The Role of Intellectual Property Rights in Developing Countries: Some Conclusions,” in *Intellectual Property Rights: Legal and Economic Challenges for Development*, ed. Mario Cimoli et al. (Oxford University Press, 2014), 503–4.

²⁵⁹ Ziedonis, *When the Giants’ Shoulders Are Crowded: Fragmented Rights and Patent Strategies in Semiconductors*, 30.

²⁶⁰ David J. Teece, “Next-Generation Competition: New Concepts for Understanding How Innovation Shapes Competition and Policy in the Digital Economy,” *Journal of Law, Economics & Policy* 9, no. 1 (2012): 99, 108, 115, 118.

²⁶¹ Greenhalgh and Rogers, *Innovation, Intellectual Property, and Economic Growth*, 17.

²⁶² *Diamond v. Diehr*, 450 U.S. 175 (1981), 187.

²⁶³ TRIPS art. 27. (“patents shall be available for any inventions, whether products or processes, in all fields of technology, provided that they are new, involve an inventive step and are capable of industrial application. . . . patents shall be available and patent rights enjoyable without discrimination as to the place of invention, the field of technology and whether products are imported or locally produced.”)

in the forms of patents.²⁶⁴ In this case, for inventors, patents enable them to incorporate others' technologies into their products through licensing or incorporate their own technologies into others' further products through assigning their software patents.²⁶⁵

Some software products may demand substantial investment to develop, so the investors, especially venture capital investors, in the software industry consider the value of patents importantly.²⁶⁶ For example, the 2008 Berkeley Patent Survey around 1332 technology startups shows that 53% angel investors, 60% venture capital investors and 36% investment banks consider patents when they looked for target firms.²⁶⁷ Even though the survey also shows that the levels of importance in software industry are much lower than in other industries, such as biotechnology industry,²⁶⁸ Kesan believes that patents retain an important role of technology development in the software industry.²⁶⁹

Because of the subject matter restriction of patent,²⁷⁰ however, software is usually difficult to get patent protection in many patent regimes in practice. For instance, before 2010, in the U.S., to fundamentally test for the patentability of a process claim, the courts usually applied the "machine-or-transformation" test, which is used to restrict the patentability of software.²⁷¹ After 2010, even though the Supreme Court does not merely rely on the test for patent applications on process and software is not barred from patent protection solely for its form of existing, it may not be protected under patent law as an abstract idea in some circumstances rather than a

²⁶⁴ Jay P Kesan, "Economic Rationales for the Patent System in Current Context," *Geo. Mason L. Rev.*, no. 15 (2015): 916.

²⁶⁵ *Ibid.* 917.

²⁶⁶ *Ibid.* 916-917.

²⁶⁷ Graham and Merges, "High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey," 1308.

²⁶⁸ *Ibid.* 1308.

²⁶⁹ Kesan, "Economic Rationales for the Patent System in Current Context," 917.

²⁷⁰ *See 35 U.S.C.S. § 101*, n.d..

²⁷¹ "[M]ere field-of-use limitations are generally insufficient to render an otherwise ineligible process claim patent-eligible. ... [M]ental processes, like fundamental principles, are excluded by 35 U.S.C.S. § 101 because phenomena of nature, though just discovered, mental processes, and abstract intellectual concepts are the basic tools of scientific and technological work. ... [A]dding a data-gathering step to an algorithm is insufficient to convert that algorithm into a patent-eligible process." *See In re Bilski*, 545 F.3d 943 (2007). 957, 960. 966. *See also*, *Nancey Silvers v. Sony Pictures entertainment, Inc.*, 402 F.3d 8 (2005).

process.²⁷²

In the E.U., the European Patent Convention, Article 52(2)(c), excludes programs for computers from patentability.²⁷³ Hartnack concludes that under European law pure software is not an invention and would not be capable of industrial patents.²⁷⁴ While the EPO's Boards of Appeal in T 1173/97 Computer Program Product/IBM (OJ EPO 10/1999, 609) held that software are patentable when they have "technical character," Macedo et al. argue that the EPO do not and is not able to provide guidance and clarity to the limits of patent eligibility of software under the EPC, especially after the EBoA dismissed the EPO President's referral on the issues about patentability of software based on the inconsistency of relative court decisions.²⁷⁵ In China, because the restrictive requirements of patentability of software include "features, means and effects," gradually, Chinese inventors do not favor patents to protect their software, especially when their main technologies or main businesses are not pure software.²⁷⁶

Hence, some software innovations that are not eligible to apply for patents will pursue the protection under copyright.²⁷⁷ Comparing to copyrights, patent protection is costly for innovators in the software industry.²⁷⁸ Moreover, a model using copyrights to protect software is simpler than using patents for software industry.²⁷⁹ Even though some programs are qualified to apply for patents, the time and cost of obtaining patents may not be economic, "particularly if the product [of the programs] is not expected to have a long life cycle."²⁸⁰ Therefore, the software

²⁷² "[O]ne may not patent an idea." *Bilski v. Kappos*, 561 U.S. 593, 610 (2010).

²⁷³ The European Patent Convention, E.P.C., Art. 52(2)(c), Oct. 5, 1973.

²⁷⁴ Paul Hartnack, "Software Patents in Europe: Chairman's Opening Remarks," 2000, accessed June 21, 2016, <http://web.archive.org/web/20010608115154/http://www.patent.gov.uk/about/ippd/softpat/1000.htm>.

²⁷⁵ Charles R. Macedo, Marion P. Metelski, and Jung S. Hahm, "ARE Patent Law Alert: The Enlarged Board of Appeal of the European Patent Office Declines to Provide Further Guidance on the Patentability of Computer-Implemented Inventions under the European Patent Convention," 2010, accessed June 21, 2016, <http://www.arelaw.com/publications/view/europatentconvention/>.

²⁷⁶ Li, "Intellectual Property and Innovation: A Case Study of High-Tech Industries in China," 291-293.

²⁷⁷ Denicolò and Franzoni, "Weak Intellectual Property Rights, Research Spill-Over and the Incentive to Innovate," 129.

²⁷⁸ See Margit Osterloh and Sandra Rota, *Open Source Software Development-Just Another Case of Collective Invention?*, CREMA, 2008, 26.

²⁷⁹ Maskus, "Strengthening Intellectual Property Rights in Lebanon," 278.

²⁸⁰ Peter S. Menell, "An Analysis of the Scope of Copyright Protection for Applications Programs," *Stan. L. Rev.* 41 (1989):

industry in a country, such as Lebanon, would heavily rely on the protection under copyrights.²⁸¹

In the U.S., although copyright is automatically created when the code of software is written,²⁸² only the owners of registered copyrights with Copyright Office can bring allegations against infringers of their copyrights.²⁸³ Hence, Granham and Mowery use the data of registered copyrights of software to research the IP protection of software.²⁸⁴

Responding to the history of the U.S. software industry during 1988-96, when software firms preferred patents to copyrights to protect their innovation for the strengthened patent regime, Granham and Mowery define the exploded volume of patents as junk patents because they believe that patent is only a tool for expanding the protection of the software of the firms and protecting them from others circumventing their software.²⁸⁵ Moreover, Graham and Sichelman's interview with a general counsel of a software firm in 2004 shows that software companies may not consider patents as valuable assets for them.²⁸⁶

In fact, comparing to other industries, such as the biotech industry, the statistics compelled by Mann and Sager show that software firms acquire fewer and fewer patents.²⁸⁷ Moreover, they observe that software start-ups in an early stage were more likely to obtain patents than the firms in other maturer stages, so they conclude that patents are used by entrepreneurs to defend against the investors of these firms.²⁸⁸

The imperfection of patent protection for software does not mean that the copyright is the optimal approach of protection for software. On the one hand, Denicolo and Franzoni remind

1076.

²⁸¹ Maskus, "Strengthening Intellectual Property Rights in Lebanon," 263.

²⁸² See 17 U.S.C.S. § 201, n.d.

²⁸³ 17 U.S.C.S. § 411, n.d. (a).

²⁸⁴ Stuart J.H. Graham and David C. Mowery, *Intellectual Property Protection in the U.S. Software Industry, Patents in the Knowledge-Based Economy*, 2000, accessed June 21, 2016, <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.87.6776&rep=rep1&type=pdf>. 29-30.

²⁸⁵ Ibid. 31-34.

²⁸⁶ Stuart J. Graham and Ted Sichelman, "Why Do Start-Ups Patent," *Berkeley Techn. Law J.* 23, no. 3 (2008): 1065.

²⁸⁷ Ronald J. Mann and Thomas W. Sager, "Patents, Venture Capital, and Software Start-Ups," *Research Policy* 36 (2007): 206. ("[R]elatively small number of patents held by the firms that do acquire patents: an average of three in the software industry compared to an average of almost 10 in the biotech industry.").

²⁸⁸ Ibid. 206-207.

that copyright only protects expressions rather than ideas and reverse engineering of copyright could be allowed.²⁸⁹ On the other hand, Menell believes that the shift from copyright to patent protection in the U.S. software industry during the 1980s could be helpful to adjusting a more proper scope of IP protection of software than solely a protected scope under copyright because of the high threshold of obtaining patents.²⁹⁰ Even though Menell admits the cost and delay under patent make it not ideal for obtaining the protection, the high threshold shields many computer programs from the exclusive IP protection.²⁹¹

Alternatively, opposing to strong IP protection that may slow the pace of technical advance in general, Levin et al. remind that technical advance usually demands cumulative relationships.²⁹² No matter how software developers pursue protection on their software under IP laws, an ideal balance between the software developers and the general technological advance should provide the former group sufficient lead time to exploit the market and teach public to continue developing around the software.²⁹³

Responding to the puzzle of balancing between appropriate compensation for software developers and potential technical development, Osterloh and Rota argue that free and open source licenses of software copyrights allow and encourage collective or cumulative innovation.²⁹⁴ Taking the example of Silicon Valley, Denicolo and Franzoni emphasize the importance of large R&D spill-overs and collective inventions contributed more or less by each firm on its final success.²⁹⁵

Moreover, Rajani et al. remind developing countries that education and experience of developed countries can significantly be communicated to developing countries through free and

²⁸⁹ Denicolò and Franzoni, "Weak Intellectual Property Rights , Research Spill-Over and the Incentive to Innovate,"130.

²⁹⁰ Menell, "An Analysis of the Scope of Copyright Protection for Applications Programs," 1103.

²⁹¹ Ibid. 1083.

²⁹² Levin et al., "Appropriating the Returns from Industrial Research and Development,"788.

²⁹³ Menell, "An Analysis of the Scope of Copyright Protection for Applications Programs," 1080.

²⁹⁴ Osterloh and Rota, *Open Source Software Development-Just Another Case of Collective Invention?* 3.

²⁹⁵ Denicolò and Franzoni, "Weak Intellectual Property Rights , Research Spill-Over and the Incentive to Innovate," 115.

open source software (FOSS).²⁹⁶ Because it can be a valuable tool for improving the local software industry, developing countries have realized the importance of FOSS.²⁹⁷ Therefore, when structuring an appropriate IP law for the development of the software industry, Olwan suggests that policy makers in developing countries treat FOSS preferably for their social and economic development.²⁹⁸

II. Problems That Remain in the Literature

This part discusses two problems remaining in the reviewed literature and presents what this research can possibly contribute based on these studies. Problem 1 explores the issues remaining in the connection between IPRs and innovation by SMEs. Problem 2 looks into the puzzles of improving IP regimes in developing countries.

1. Lack of Clear Evidence on the Connection between IPRs and Innovation by SMEs

It is clearly understood the traditional logic of the effects of patent and other IPRs on innovations under economic analysis. The legal monopoly rights of IP, that is, how IPRs compensate the expended R&D costs, decrease the marginal cost of innovation and award patent holders with an extra price on their products to ultimately increase their profits on the whole business relating to the IPRs.²⁹⁹ Based on this economic rationale, there are scholars who have realized both the effectiveness and limitations of the power of the temporary monopoly provided by IPRs, due to the variation of the power of the market in different areas and industries.

²⁹⁶ Niranjana Rajani, Juha Rekola, and Timo Mielonen, *Free as in Education: Significance of the FLOSS for the Developing Countries*, 2003, 79, accessed June 21, 2016, http://www.itu.int/wsis/docs/background/themes/access/free_as_in_education_niranjana.pdf.

²⁹⁷ Olwan, *Intellectual Property and Development: Theory and Practice*, 270, 277, 283.

²⁹⁸ *Ibid.* 362.

²⁹⁹ Fisher, "Intellectual Property and Innovation: Theoretical, Empirical, and Historical Perspectives," 5. See also, Greenhalgh and Rogers, *Innovation, Intellectual Property, and Economic Growth*, 32-34..

However, most of them have merely done theoretical analysis on the existence and the scale of the limitations and necessity of monopoly created by IPRs.³⁰⁰

Overall, the literature review presents enough theoretical debates on the pros and cons of the economic efficiency of IPRs and IP laws in innovation.³⁰¹ However, the theoretical literature still has no clear evidence on how the traditional understanding of the function of IPRs awarding firms or individuals is effective. If, in the perspective of innovative firms, IPRs do compensate R&D, another question will be how efficient is the compensation in encouraging the incentives of innovation of the firms?

These realistic questions require answers from empirical studies.³⁰² Recall the empirical evidence in the literature, but note that the scholars are hardly able to show that IPRs can directly create significant effective incentives to do R&D by R&D-intensive firms, especially by SMEs.³⁰³ Most of these empirical studies are in the form of doing surveys among firms or comparing the patent data at country-level among the applicants from different countries. This could be problematic because without firm-level data reflecting realistic performances of innovative firms, these studies also lack the information of detailed factors relating their R&D and patent activities.

³⁰⁰ Maskus and Konan believe the monopoly effects are always overstated in realities. Keith E. Maskus, "The Role of Intellectual Property Rights in Encouraging Foreign Direct Investment and Technology Transfer," in *Intellectual Property and Development: Lessons from Recent Economic Research*, ed. Carsten Fink and Keith E. Maskus (The World Bank and Oxford University Press, 2005), 41–74. Maskus just thinks that the IPRs do not necessarily create the kind of monopoly locking the access of technologies and setting high prices. See also, Maskus, "Strengthening Intellectual Property Rights in Lebanon," 264. See also Roffe and Spennemann, "Preferential Trade Agreements and Intellectual Property Rights," 459.

³⁰¹ For examples, IPRs or IP laws can foster dynamic competition and help to solve free-rider problems, but also can create anti-commons problems. Maskus and Okediji, "Legal and Economic Perspectives on International Technology Transfer in Environmentally Sound Technologies," 397. See also Li, "Intellectual Property and Innovation: A Case Study of High-Tech Industries in China," 268. See also Heller and Eisenberg, "Can Patents Deter Innovation? The Anticommons in Biomedical Research," 198.

³⁰² Ziedonis also appreciates the importance of using patent data to do empirical research on learning the connection between IP and innovation after she organized all important relevant literature from 1986 to 2006. Rosemarie H. Ziedonis, "Chapter 10. Intellectual Property and Innovation," in *Handbook of Technology and Innovation Management*, ed. Scott Shane (John Wiley & Sons, Ltd, 2008), 295–333.

³⁰³ Ziedonis and Hall, "The Effects of Strengthening Patent Rights on Firms Engaged in Cumulative Innovation: Insights from the Semiconductor Industry." See also, Hall and Ziedonis, "The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995." See also, Sakakibara and Branstetter, "Do Stronger Patents Induce More Innovation? Evidence from the 1988 Japanese Patent Law Reforms." See also Levin et al., "Appropriating the Returns from Industrial Research and Development." See also, Kortum and Lerner, "Stronger Protection or Technological Revolution: What Is Behind the Recent Surge in Patenting?" See also, Park, *Do Intellectual Property Rights Stimulate R&D and Productivity Growth? Evidence from Cross-National and Manufacturing Industries Data*.

In cross-national studies, the country-level data inevitably are too broad to focus in on particular SMEs, the local markets, or local policies facilitating IP enforcement or encouraging innovation. These studies thus may have limitations on accounting for the environmental disturbances, which may cause a disconnection between their obscure or negative results and so many existing positive predictions in the theories. Even though some scholars theoretically claim an indirect relationship between innovation and IPRs or show it with empirical evidence, it is difficult to show the factors constructing the bridges between IPRs and innovation, and their degrees.³⁰⁴

The flaw in these studies could be the country-level data that they use. Country-level data, which may strongly relate to a more complex mechanism, such as the economy and market, must have some inherent relationship with competition in the market³⁰⁵ and other implied and unexplored instrumental factors. Besides the factors relating to the IPR regime itself, as other literature theoretically deduced and my literature review has discussed, these factors could be long-term or short-term local policies, beneficial or restrictive, or these factors could be about the capital markets supporting the operations of the innovative firms and their R&D spending. Hence, it is not sufficient to explore this inherent relationship merely based on country-level data.

Recall the series of firm-level studies about the semiconductor firms in the U.S., a single country.³⁰⁶ Hall and Ziedonis successfully testify how a “pro-patent” legal environment, including those detailed factors in an economy, improves the degree of patenting by firms. Nevertheless, with the same failure of the discussed country-level studies, they also cannot prove

³⁰⁴ In Park’s empirical study through country-level data, he concludes that IPRs encourages R&D investment indirectly, but he cannot clearly define the direct factors encouraging R&D investment. Other scholars have discussed that the spillover effects of having IP, attractions of IPRs to FDI investors and local venture capital investors. Ibid. See also, Fink, “Intellectual Property Rights and U.S. and German International Transactions in Manufacturing Industries.” See also, Greenhalgh and Rogers, *Innovation, Intellectual Property, and Economic Growth*.

³⁰⁵ Teece, “Next-Generation Competition: New Concepts for Understanding How Innovation Shapes Competition and Policy in the Digital Economy.”

³⁰⁶ Hall and Ziedonis, “The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995.” See also Ziedonis and Hall, “The Effects of Strengthening Patent Rights on Firms Engaged in Cumulative Innovation: Insights from the Semiconductor Industry.” See also, Ziedonis, *When the Giants’ Shoulders Are Crowded: Fragmented Rights and Patent Strategies in Semiconductors*.

a direct connection between innovation and patents.³⁰⁷ Not only can they not find that patenting by the firms is based on their R&D outcomes, but they also cannot conclude that the patent regime encourages innovation by the firms through the compensation and awards from the market.

Their studies are semiconductor industry-oriented, which means that they focus their samples on one industry in which the technology develops rapidly and firms quickly innovate based on each others' innovations. While they control for the size of the firms, their studies do not explore any effective information from this control. Meanwhile, the data resource is from listed firms and the interviewees in these studies are from large manufacturers. Thus, not surprisingly, when revisiting these studies, Hall and Ham conclude that the result in this series of studies with semiconductor firms is more helpful for large firms.³⁰⁸

The main findings of the Yale and Carnegie Mellon surveys may explain that larger firms are better at adopting patent strategies than smaller firms, and the only exception of this situation could be the R&D-intensive SMEs, which value patents importantly.³⁰⁹

Actually, based on another firm-level study by Agarwal and Audretsch, firm size can be a critical factor relating to innovation for the firms in a relatively early stage of their life cycle, but may not affect high-technology firms or the firms in the mature stage of their life cycle.³¹⁰

Thus, this could explain the remaining issues in the empirical studies by Hall and Ziedonis. All the objects of their studies are high-technology firms and basically the firms in the stage of maturity.

Graham and Sichelman, however, theoretically studying start-up patent strategies, present that the same issue also exists in most of the previous literature.³¹¹ Then, with the 2008 Berkeley

³⁰⁷ Hall et al. believe that all the previous firm-level studies have this defect, not limited to this one. They believe that the reason why these studies cannot find an effective relationship between innovation and IP protection mechanisms is lack of exogenous. Hall et al., "The Choice between Formal and Informal Intellectual Property: A Review."

³⁰⁸ Hall and Ham, *The Patent Paradox Revisited: Determinants of Patenting in the US Semiconductor Industry, 1980-94*.

³⁰⁹ Hall et al., "The Choice between Formal and Informal Intellectual Property: A Review," 405-406.

³¹⁰ Rajshree Agarwal and David B Audretsch, "Does Entry Size Matter?: The Impact of the Life Cycle and Technology on Firm," *The Journal of Industrial Economics* 49, no. 1 (2001): 21-43.

³¹¹ Graham and Sichelman, "Why Do Start-Ups Patent." 1088-1089. They list several studies having this issue. At least two

Patent Survey that they and other scholars conducted, they prove their previous prediction.

Similarly, my research, using both firm-level and country-level data, is size-oriented rather than industry-oriented. When SMEs are considered as important to the economy in both employment and technology development, the size of firms is also an important measure to be involved when their R&D activities are studied.³¹² This study is original within Chinese literature. Because there is limited access of reliable data about Chinese SMEs, the empirical studies researching R&D activities by Chinese scholars are only around big firms or at country-level.³¹³

For SMEs, Teece theoretically proves that intensifying competition through IPR regimes prohibits innovation by SMEs but only benefits large enterprises.³¹⁴ Solely based on innovation rather than other market powers or capabilities, SMEs are less likely to be able to profit enough from a perfectly competitive market, and the Schumpeter theory could support this analysis.³¹⁵ While Hsu, Ziedonis, and Hochberg et al. theoretically present how the signaling effects of patents are important to attract investors or lenders for start-ups and show the empirical

of these studies have been reviewed by us. Sakakibara and Branstetter, "Do Stronger Patents Induce More Innovation? Evidence from the 1988 Japanese Patent Law Reforms." *See also*, Levin et al., "Appropriating the Returns from Industrial Research and Development."

³¹² Bound et al., "Who Does R&D and Who Patents?" 49-51. This empirical study proves that small and large firms are more R&D intensive than average-size firm after they control for the size as an independent variable in their estimations.

³¹³ Zhongchang Chen (陈仲常) and Xiang Yu (余翔), "The External Effects of R&D in Enterprises: A Panel Data Analysis In Industrial Level[企业研发投入的外部环境影响因素研究——基于产业层面的面板数据分析]," *Keyan Guanli(科研管理)[Science Research Management]* 28, no. 2 (2007): 78 - 84. *Also see*, Yali Bian (卞雅莉), *Jishu Zhuanli, R&D Touro Yu Zhuanli Gongxian-Jiyu Shijian Xulie Shuju De Shizheng Yanjiu(技术转移、R&D 投入与专利贡献——基于时间序列数据的实证研究)[Technology Transfer, R&D Investment and Patent Contribution-An Empirical Analysis Based on Time Series Data]*, 2010. *Also see*, Pingfang Zhu (朱平芳) and Weimin Xu (徐伟民), "Zhengfu De Keji Jili Zhengce Dui Dazhong Xing Gongye Qiye R&D Touro Jiqi Zhuanli Chanchu De Yingxiang(政府的科技激励政策对大众型工业企业 R&D 投入及其专利产出的影响——上海市的实证研究)[Government Technical Stimulated Policies' Effects on R&D and Outputs in Patent by Big and Medium-Sized Industr," *Jingji Yanjiu(经济研究)[Economic Study]* 6 (2003): 45 - 53. *Also see*, Weimin Xu (徐伟民), "Zhengfu Zhengce Dui Gaoxin Jishu Qiye Zhuanli Chanchu De Yingxiang Jiqi Menkan Xiaoying-Laizi Shanghai De WeiGuan Shizheng Fenxi(政府政策对高新技术企业专利产出的影响及其门槛效应 - 来自上海的微观实证分析)[Government Policies' Effects and Threshold on the Output of Patents by High-Tech Enterp," in *Guoji Jinrong Weiji Yu Zhongguo Qiye Fazhan(国际金融危机与中国企业发展)[Global Financial Crisis and Chinese Enterprises Development]*, 2012, 400 - 407. *Also see*, Chen and Yu, "The External Effects of R&D in Enterprises: A Panel Data Analysis In Industrial Level[企业研发投入的外部环境影响因素研究——基于产业层面的面板数据分析]."

³¹⁴ David J. Teece, "Reflections on 'Profiting from Innovation,'" *Research Policy* 35 (2006): 1131.

³¹⁵ Ibid. 1143. *See also*, Joseph A. Schumpeter, *Capitalism, Socialism, and Democracy*, Routledge (London and New York: George Allen & Unwin, 1943).

evidence,³¹⁶ these patent strategies may function as the means to save some parts of the deadweight loss of their IP.³¹⁷

Alternatively, recall the importance of innovation to a country and a firm in Chapter 1. These interior patent strategies may show the incentives of patenting by firms, but they still cannot answer the doubts raised about the theoretical predictions and the political goals of many countries about the efficiency of IPR regimes in encouraging innovation by firms, especially SMEs.

In my research, I look into the particular innovative SMEs in China and learn their R&D activities and patent or copyright behaviors to understand the efficiency of the IPR regime in innovation in SMEs. When considering the factors of patenting incentives relating to the financial strategies, my research helps to not shirk the uncertified efficiency of the IP regime in stimulating innovation by SMEs in China. This could also be meaningful for responding to some American legal scholars, such as Lemley, who worry that IPRs create extra transaction costs to the society and impede innovation.³¹⁸ By combining the firm-level data and country-level data, my research will help to explain this conflict between theory and practice.

2. Strengthen or Not Strengthen the IP Regimes in Developing Countries

As presented in the literature review, there are an enormous number of arguments for constructing the strength of the IP regimes in developing countries. The inconsistent strength of IP regimes between developed countries and developing countries is because the TRIPs, the Paris Convention and other International IP conventions or covenants have some transitional

³¹⁶ David H. Hsu and Rosemarie H. Ziedonis, "Resources as Dual Sources of Advantage: Implications for Valuing Entrepreneurial-Firm Patents," *Strategic Management Journal* 34 (2013): 761–81. See also, David Hsu and Rosemarie H. Ziedonis, "Patents as Quality Signals for Entrepreneurial Ventures," in *DRUID Summer Conference on Appropriability, Proximity, Routines and Innovation*, 2007. See also, Ziedonis, "Chapter 10. Intellectual Property and Innovation." See also, Yael V. Hochberg, Carlos J. Serrano, and Rosemarie H. Ziedonis, *Patent Collateral, Investor Commitment, and the Market for Venture Lending*, 2014, accessed June 21, 2016, <http://www.nber.org/papers/w20587>.

³¹⁷ Denicolò and Franzoni, "Weak Intellectual Property Rights, Research Spill-Over and the Incentive to Innovate."

³¹⁸ Mark A. Lemley, "The Economics of Improvement in Intellectual Property Law," *Tex. L. Rev.* 75 (n.d.): 989–1084. 996–997. See also, Wendy Gordon, "Fair Use as Market Failure: A Structural and Economic Analysis of the Betamax Case and Its Predecessors," *Columbia Law Review* 82, no. 8 (1982): 1653.

provisions for developing countries and require them to be less restricted than those in developed countries. This staggered system has been established to help developing countries implement the obligations of TRIPs and other conventions.³¹⁹

For example, the Article 31 of the TRIPs, authorizing compulsory licensing, attempts to create a balance between two opposing interests: “the interests of inventors and of technologically advanced countries and those of licensees and of technologically less advanced countries.”³²⁰ Also, developing countries indeed care about compulsory licenses to compensate their domestic markets.³²¹ However, technology developers or FDI investors from developed countries prefer to enter an environment with strong IP protections to secure and compensate their investments in that market. This is a common consensus that can be derived from all of the scholars³²² mentioned in the literature review based on either their theoretical analysis or empirical studies in various countries, especially in China, and in various industries, such as in manufacturing industries.

When we understand the importance of FDI on technology transfers and spillovers; on fostering dynamic competition in the market, capital, management skills and other resources from developed countries; and, finally, on the economic development in developing countries³²³, we should not ignore that these factors were originally formulated within the interior system of developing countries. In this case, the proper strength of IP regimes in developing countries is

³¹⁹ Daniel C.K. Chow and Edward Lee, *International Intellectual Property: Problems, Cases, and Materials* (Thomson West, 2006), 63.

³²⁰ Mitsuo Matsushita, Thomas J. Schoenbaum, and Petros Mavroidis, *The World Trade Organization: Law, Practice and Policy* (New York: Oxford University Press, 2003), 429.

³²¹ Ibid. 428. Some scholars, such as Correa and Fink, mentioned by our literature review, remind developing countries of the opportunities left in these International conventions to favor their local firms by a weak IP regime.

³²² When I discuss the interact of IP and finance, I presented the opinions of Olwan, Lu, et al., Hu and Jaffe, Greenhalgh and Rogers, Park and Lippoldt, Maskus, Chatterjee et al. Coriat and Orsenigo, and the results of the empirical studies in China, Brazil, or multiple developing countries by Javorcik, Mansfield, and Fuller. Those scholars all agree that FDI investors can be merely attracted by stronger IP regimes. Even when we consider the IP environment alone, Maskus takes Lebanon as a case to persuade other developing countries to adopt a stronger IP regime attract leading foreign technologies.

³²³ The literature review presents that Heffernan and Wachtel, Greenhalgh and Rogers, and Lu et al. show FDI is an important type of international financial flows and have significant effects on parts of these areas. As supplements, the scholars who support to strengthen IP regimes in developing countries to attract FDI discuss the significant effects on the rest parts of these areas.

still an ambiguous question under discussion in the previous literature.

On the one side, for local innovators, an IP system is an important platform to obtain compensation. If the system is too weak, their compensation will be too little.³²⁴ Regardless of FDI or other foreign technologies, recalling the economics analysis of the importance of having IPRs and the successful experience of the IP systems in the U.S.³²⁵ and other developed countries³²⁶, it is reasonable to understand the perspectives of the scholars who strongly suggest that developing countries should strengthen their IP regimes for encouraging technology transfers and constructing a dynamic competitive market, which will ultimately create resources and incentives for innovation.³²⁷

On the other side, as I have organized in the literature review, there are obviously more scholars who doubt whether or not these ideal goals could be successfully accomplished in developing countries. At least, they question whether the relationship between the strength of IP protection and innovation is strictly positive. The economics theory on dynamic effect of IP protection predicts and simulates an inverted U-shape relationship between IP protection and startups' innovation because of an imbalance benefit that a system with excessive IP protection provides to incumbents on the market.³²⁸

Furthermore, regardless of how the scholars did statistics or did empirical studies, focusing on general industries or particular industries, such as the pharmaceutical industry, the agriculture industry, and the software and semiconductor industries, and the duration of their studies, they usually found negative effects of strong IP protection on local innovations, or they could not find its positive influences on local innovations in developing countries.³²⁹ For developing countries,

³²⁴ Hu and Jaffe, "Lessons from the Economics Literature on the Likely Consequences of International Harmonization of IPR Protection."

³²⁵ Li, "Intellectual Property and Innovation: A Case Study of High-Tech Industries in China."

³²⁶ For example, the Germany IP regime is comparatively strong in the world, and our literature review mentions that Fink uses empirical evidence to prove it facilitates innovations in Germany. Fink, "Patent Protection, Transnational Corporations, and Market Structure: A Simulation Study of the Indian Pharmaceutical Industry."

³²⁷ Maskus, Dougherty, and Mertha, "Intellectual Property Rights and Economic Development in China."

³²⁸ Panagopoulos and Park, *Patent Protection, Takeovers, and Startup Innovation: A Dynamic Approach*. 19. Also see, Coriat and Orsenigo, "IPRs, Public Health and the Pharmaceutical Industry: Issues in the Post-2005 TRIPS Agenda," 234.

³²⁹ In the section of construction of patent environment to stimulate innovation in our literature review, I have listed

they indeed question whether FDI and technology transfer can be successfully increased to offset the cost of strengthening the enforcement of IP laws.³³⁰

The discrepancy between the theoretical positive effects of a strong IP regime on innovation and the undesirable results across several industries in developing countries could be due to two reasons, which are problematic but ignored by the previous literature. First, defining a strong IP regime as the degree and the breadth of the protection provided by an IP regime to technology developers is too rigid, especially for developing countries.³³¹ Second, a key difference between the markets in developing countries and the markets in developed countries is that few developing countries are market-oriented economies, so developing countries usually lack efficient competition in their markets.³³²

Based on different innovation strategies and innovative abilities, innovators can be categorized as initial innovators or innovation followers.³³³ Their costs and benefits of doing innovation are different, and their incentives could also be different.³³⁴ For example, Kitch believes that process innovations are more rapid and are demanded by all firms, not only by

Cimoli et al., Sakakibara and Branstetter, Denicolo and Franzoni, Coriat and Orsenigo, and Fink as the scholars who are hesitant to admit a positive relationship between the strength of IP regime in a developing country and the innovation there because of their empirical or statistical results. Particularly, Heald raised the doubts on the positive relationship between levels of IPRs and FDI decisions because of the vague and broad definition of FDI by Mansfield.

³³⁰ Paul J Heald, "Misreading a Canonical Work : An Analysis of Mansfield' S 1994 Study," *Journal of Intellectual Property Law* 10 (2003): 309.

³³¹ In our literature review, I have discussed the studies of Cimoli et al., Sakakibara and Branstetter, Ganslandt et al., and Nuvolari and Tartari. They studied the patentable subject matters in developing countries, and suggest that they should expand that to strengthen their IP regimes, or use that to evaluate the strength of their IP regimes.

³³² Besides the strength of IP protection, technology transfer also depends on other critical conditions, such as the regulatory transparency, market openness in a country. See, Reichman et al., "Intellectual Property and Alternatives: Strategies for Green Innovation." 374. "Many countries have negotiated trade agreements with TRIPS 'extra' and 'plus' provisions." Based on these behaviors of the countries, Burlamaqui and Cimoli understand the function of TRIPS agreement on market access. Thus, they suggest that effective industrial policies should consider the elements of economy's degree of openness, macroeconomic governance, and competition policies. See also, Burlamaqui and Cimoli, "Industrial Policy and IPR: A Knowledge Governance Approach," 496.

³³³ Initial innovators are also called technology development leaders, innovation leaders, initial innovators or pioneer innovators. Innovation followers are also known as follow-on innovators. "A leader pursues innovations by investing in R&D and attempts to protect these innovations using IPRs. A follower relies on adopting, imitating, or inventing around new innovations developed by others." See Greenhalgh and Rogers, *Innovation, Intellectual Property, and Economic Growth*, 120.

³³⁴ Fisher reminds us that, besides the cost of R&D, pioneer innovators also have a similar high cost of competition costs because of the big number of follow-on technologies. In the perspective of Fisher, pioneering patents have the capability to raise the development of an industry. See, Fisher, "Intellectual Property and Innovation: Theoretical, Empirical, and Historical Perspectives." Burk and Lemley see a lower cost of R&D by follow-on innovators parts of whose process of R&D are easy replications. Burk and Lemley, "Policy Levers in Patent Law."

technological pioneers.³³⁵ Currently, even in the U.S. market, there are increasingly fewer initial innovators, so some scholars suggest shrinking the scope of IPRs for the public interests of various parties, including the users of the technologies and other technology developers, and encouraging cumulative innovations.³³⁶ Comparatively, developing countries largely relying on imported technologies have even fewer initial innovators and merely have innovation-followers.³³⁷

Are they necessary to “strengthen IPRs” in order to encourage the development of following technologies, or to foster the incentives and the abilities of initial innovation? Is it economically efficient to request developing countries to broaden the scope of their IPR protection and strengthen the enforcement of IPR protection simultaneously? At this point, the second question I raise, the inefficiency of the competition in the markets of developing countries, is strongly relevant.

In most developing countries, besides the trade restrictions eliminated by the TRIPs and other International agreements, their markets are not open enough and still have a variety of interior and exterior trade restrictions left.³³⁸ Moreover, many monopolies in the markets of developing countries are state owned enterprises (SOEs) because the governments use state owned enterprises to decrease the risk and uncertainty in the markets.³³⁹ With their immature markets of patent commercialization, if I expand some theoretical analysis of some scholars in the literature review, they will suggest that these governments need to provide more government subsidies and subsidized policies than the countries with an efficient free-market in order to aid

³³⁵ See, Kitch, “The Nature and Function of the Patent System,” 289.

³³⁶ Many scholars, such as Fisher, Lemley, and Chang, have realized this trend and the importance of innovation followers so as to suggest that IP regime should be adjusted to provide innovative opportunities and markets to follow-on innovators. Howard F Chang, “Patent Scope, Antitrust Policy, and Cumulative Innovation,” *Innovation* 26, no. 1 (2012): 34–57. See also, Lemley, “Should Patent Infringement Require Proof of Copying.” c. See also Fisher, “Intellectual Property and Innovation: Theoretical, Empirical, and Historical Perspectives.”

³³⁷ Maskus, “Transfer of Technology and Technological Capacity Building.” See also Robert E. Evenson and Larry E. Westphal, “Technological Change and Technology Strategy,” in *3A Handbook of Development Economics*, ed. Jere Behrman & T.N. Srinivasan Eds. (Amsterdam: North-Holland, 1995), 2209–2341.

³³⁸ Possible reasons for interior trade restrictions could be that the nature of the countries is different as capitalism, socialism or democracy, and that the legal environments are different as civil law system or common law system.

³³⁹ Lu et al. use China as an example to explain these economic effects of SOEs in the market. Haitian Lu, Yi Tan, and Gongment Chen, “Venture Capital and the Law in China,” *Hong Kong L. J.* 37 (2007): 229–71.

their local firms to survive and develop.³⁴⁰

Therefore, due to the two issues, it is necessary to do empirical study with a case of one developing country, China, and analyze the weaknesses of the IP regime in this particular emerging market. This is similar to how Cockburn and MacGarve suggest that one industry, the software industry, should be studied alone for the effects of the U.S. IP regime by using empirical methods, where the reaction of the software industry could be opposite to that of other industries on the market.³⁴¹

Only if we learn the efficiency of IP regimes with empirical methods, can we evaluate the regime and improve it, rather than simply strengthen or weaken it. Recall the inverted U-shape simulation by Panagopoulos.³⁴² The data for the simulation is from the U.S. firms. In the Chinese market, excessive IP protection could benefit the incumbents more, but the innovative foreign firms are likely to be the incumbents against domestic firms. Hence, the vertex could be different with different observations and an empirical study can be helpful to understanding how the domestic firms innovate and survive.

For understanding the efficiency, this study considers and balances the direct and indirect effects of the IP regime on stimulating innovation by local SMEs. The direct effects are from the designs of the IP regime itself, and the indirect effects are created by FDI investors, other technology developers from developed countries in the local market and other economic instruments by governments or the local financial market. Therefore, I look through the heavily debated parts of the design of the IP regime in China, and evaluate them statute-by-statute rather than roughly suggest strengthening it as a whole.

³⁴⁰ For example, Scotchmer agrees that national treatment increases incentives to innovate, especially in an environment where local markets are not large enough to support invention. See Scotchmer, "The Political Economy of Intellectual Property Treaties." Kitch and Olwen also discuss the importance of government supporting besides providing IP protection in the markets, especially in the markets which cannot efficient compensate the innovators. See Olwan, *Intellectual Property and Development : Theory and Practice*. See also Kitch, "The Nature and Function of the Patent System."

³⁴¹ Im Cockburn and Mj MacGarvie, *Patents, Thickets and the Financing of Early Stage Firms: Evidence from the Software Industry*, *NBER Working Paper Series*, vol. 13644, 2007, accessed June 21, 2016, <http://onlinelibrary.wiley.com/doi/10.1111/j.1530-9134.2009.00228.x/full>.

³⁴² Panagopoulos and Park, *Patent Protection, Takeovers , and Startup Innovation: A Dynamic Approach*.

III. Research Questions and Hypotheses

In this part, the research questions are based on the discussed problems remaining in the prior literature and regard the connections between the innovation SMEs and their IPRs or the IP regime. The precise research questions breaking down the general questions as listed below:

What is the efficiency of IPRs, such as utility patents, utility models, design patents and software copyrights, in stimulating innovation by SMEs when China is strengthening its IP regime? Can IPRs owned by SMEs effectively improve their R&D commercialization? In other words, are the number of IPRs owned by SMEs associated with their R&D outcomes in revenue and net profits?

In addition, what is the propensity of innovation-intensive SMEs to file the three types of patent applications, including the utility patents, utility models and design patents? In precise, how does the variation of the number of patent filings associated with the internal factors, such as R&D intensity (a rate of R&D investment over employee), R&D investment amount and revenue, and the external factors, such as government funding, corporate tax credits and subsidies for patent application fee?

One hypothesis is that revenue, net profit and asset turnover ratio (a rate of revenue over total assets) would vary as the function of R&D intensity, the number of issued utility patents, utility models, design patents and copyrights, and the number of issued IPRs in previous years. Another hypothesis is that SMEs make patent strategies with different degrees of R&D investment amount and R&D intensity and have different patenting propensity on the three types of patents, including utility patents, utility models and design patents, and the propensity of an SME is consistent on the three types of patents. The last hypothesis is that both revenue, which is the outcomes of holding patents, and pro-patent grants or subsidies, such as government funding, corporate tax credits and subsidies for patent application fee are associated with patenting propensity of SMEs, but the association could be in degree.

IV. Data and Methodology

As Problem 1 in Section II presents, the prior studies have considered country-level data and firm-level data to understand the relationship between IPRs and innovation, but the firm-level data only in the respect of particular industries and the country-level data usually cannot provide a direct or substantial correlation.³⁴³ With regard to Problem 2, learning how to strengthen or not strengthen IP regimes in a developing country, my country-level data are about China and my firm-level data are collected from some public firms in Zhongguan-Cun Science Park and Zhangjiang Hi-Tech Park. The background of the two science parks and the enterprises locating there has been introduced in Chapter 2.

In this chapter, Section 1 introduces the country-level data in IP and their sources. Consistent with the data in Chapter 2, the range of the data is from 2009 to 2013. Section 1 explains the variables that are selected and the process of collecting and coding the data into the variables. The firm-level data in IP, the individual firm characteristics and their sources have been introduced in Chapter 2. Section 2 discusses the models employing the data.

1. Country-Level Data in IP

The country-level data in IP reflect the IP environment of China and its variance between 2009 and 2013. Hall et al. criticize the previous firm-level empirical studies that did not control for exogenous differences so that these studies could not explain the relationship between innovation and the protection mechanism, and they agree on the importance of evidence from litigation in the previous studies.³⁴⁴ Hence, it is necessary to utilize the data to understand the frequencies of IP applications, IP transactions and IP enforcement in China.

³⁴³ For example, Hall and Ziedonis, "The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995." See also, Carsten Fink, "Intellectual Property Rights and U.S. and German International Transactions in Manufacturing Industries," in *Intellectual Property and Development: Lessons from Recent Economic Research*, ed. Carsten Fink and Keith E. Maskus (The World Bank and Oxford University Press, 2005)

³⁴⁴ Hall et al., "The Choice between Formal and Informal Intellectual Property: A Review," 408-410.

In the branch of understanding the IP enforcement in China, I adopt the data showing the development of IP courts in China and the frequencies of various litigations initiated by IP owners and other IP disputes. Because the results of litigations and arbitrations are merely selectively public by the courts, it is not reasonable to directly apply these results in my variables to represent the enforcement of IP in China for its incompleteness.

Alternatively and indirectly, I collect the data of the number of all filed civil patent cases litigated in China per year, the number of litigated administrative patent cases in China per year and the number of all utility patent applications. Because people, especially technology developers, can rely on the patent litigation system more heavily to protect their interests when they rely on the patent regime more frequently and usually, the variance of these data can reflect the effects of the improvement of patent regime both in the litigation system and in the SIPO and the improvement of the market involving transactions of technologies.

In precise, based on the category of the goal of litigation, the number of civil patent litigations exhibits how people or companies treat their technology under the patent regime effectively on the market, and the number of administrative patent litigations denotes how inventors manage problems with the SIPO.³⁴⁵ When patent applicants are not satisfied with the final rejection by the SIPO, they can appeal the result to a court by filing an administrative litigation against the SIPO. Here, to denote the satisfaction of general patent applicants with the examination by the SIPO, I divide the number of administrative litigations by the number of utility patent applications. This appeal rate over all utility patent applications merely count for the appeal of utility patent rejections because utility model regime is a registration regime and does need to appeal for acquiring a utility model right, and it is also a measure to present the strictness of patent regime in China.

Moreover, this study also adopts other variables to describe the IP enforcement in China. These variables include the mediation rate over all filed IP cases per year, the number of public court decisions on IP cases per year, the number of trial courts having the jurisdiction of patent

³⁴⁵ Because SIPO is a government agency, disputes on its decisions, including the denials or authorizations of patents are administrative cases rather than civil cases in China.

litigations, and the number of appellate courts with the jurisdiction of the patent litigations. They express the efforts of the court system to strengthen its legal environment and to make more reasonable and challenging decisions.

Among these variables, the number of trial courts for patent suits denotes the availability of patent litigations for various interest parties. Moreover, for the mediation rate, on the one side, it reflects the legal culture of courts on IP cases and the perspective of innovators and the market on IP. On the other side, because the mediation rate over all filed civil cases is one standard of evaluating judges for the efficiency of jurisdiction in China, the judges encourage mediation between the disputed parties.³⁴⁶ Hence, the mediation rate over all filed IP cases can tell the endeavor of the judges in these cases and the effects of their subjective endeavor on the results of these cases.³⁴⁷ For the court decisions, they are not required to be public in China, even though the public concerns it for the consistence and the fairness of the jurisdiction.³⁴⁸ Therefore, the number of public court decisions on IP cases can tell the improvement of the fairness of the IP jurisdictions and the reliability of the IP regime.³⁴⁹

Before the court decisions, the courts can authorize some kinds of temporary orders based on the pleadings of the plaintiffs. These orders include the temporary restraining orders or preliminary injunctions, pretrial preservation of evidence and pretrial preservation of property. In this research, I collect the data of the number of all admitted applications of temporary

³⁴⁶ Hui Liu(刘辉), “Minshi Jiancha Jiandu Shijiaoxia De Qiangshi Susong Tiaojie (民事检察监督视角下的强势诉讼调解)[Civil Prosecuting View: Forced Mediation in Litigations],” *Guojia Jianchaguan Xueyuan Xuebao(国家检察官学院学报)[National Prosecutor Academic Paper]*, no. 4 (2008), accessed June 21, 2016, http://article.chinalawinfo.com/ArticleHtml/Article_45270.shtml.

³⁴⁷ However, a drawback to use MD is that it compromise all public IP relevant cases, including the cases of patents, copyrights, trademarks, technology contracts, and antitrust because the P.R.C. People’s Supreme Court does not discriminate the categories of IP cases in their publication, so I can only adopt the integrity number to present the status of the whole IP regime.

³⁴⁸ For example, the news says that the courts in Beijing publish their decisions on IP cases. However, in practice, the process to acquire the cases could be time consuming. Moreover, the courts in the cities other than Beijing do not have this function because they have the freedom to publish or not. The law only requires the P.R.C. People’s Supreme Court to publish all of their decisions, and has been enacted since 2013. See “Fayuan Panjueshu Heshi Nenggou Quangongkai (法院判决书何时能够全公开?)[When the All Court Decisions Can Be Public?],” 2013, accessed June 21, 2016, http://news.ifeng.com/gundong/detail_2013_11/28/31619654_0.shtml.

³⁴⁹ Just like issuing in the mediation rate (MD), the P.R.C. People’s Supreme Court does not provide the statistic of public court decisions on patent cases, copyright cases, trademark cases, technology transaction contract cases and trade secret cases separately, so I can only adopt the integrity number to present the status of the whole IP regime.

restraining orders and preliminary injunctions on IP cases per year, the rate of the admissions over all the applications, the number of all admitted applications of pretrial preservation of evidence on IP cases per year and their admission rate.³⁵⁰ Combining with the discussed variables in the above paragraphs, these variables directly tell the enforcement of IP laws in China.³⁵¹

The sources of country-level data are the SIPO (State Intellectual Property Office of the P.R.C.) database and the reports by the P.R.C. Supreme People's Court.³⁵² Moreover, in this research, I only collect and adopt the data between 2009 and 2013.

2. General Data Descriptions

Chapter 2 describes the data regarding R&D, IP issuance and government funding and compares the data of the Beijing SMEs with the data of the Shanghai SMEs. Following the comparison between the two cities, this section describes their data regarding IP applications.

Between 2009 and 2013, in general, the numbers of utility model applications were similar between the SMEs in the two cities, but the Beijing SMEs were more likely to apply for utility patents than the Shanghai SMEs. In precise, shown by the summary statistics in Table 3.1, the Beijing SMEs yearly filed 6.08 patent applications on average, and the Shanghai SMEs yearly filed 3.06 patent applications on average.

Among all the industries, the industry of information technology, electronic manufacturing, mechanical manufacturing, petroleum and plastic manufacturing, and pharmaceutical manufacturing are the five largest groups of SMEs in the samples. Looking into those specific

³⁵⁰ The temporary restraining orders and preliminary injunctions are enforcement orders on particular behaviors before the decisions on merits so as to be not discriminated under the jurisdiction of China.

³⁵¹ The injunctions including preliminary injunctions and permanent injunctions can directly tell the enforcement of courts in IP cases. Because of the incompleteness of the public court decisions, I can only acquire the information of preliminary injunctions. Moreover, the P.R.C. People's Supreme Court does not discriminate the categories of IP disputes in these data. Therefore, I can only adopt to use the integral data to represent the enforcement of IP regime as a whole.

³⁵² The P.R.C. Supreme People's Court, "Intellectual Property Protection by Chinese Courts in 2013," 2014, accessed June 21, 2016, http://www.court.gov.cn/zscq/bhcg/201404/t20140425_195314.html.

industries, in the industry of information technology, the Shanghai SMEs filed more software copyright registrations than the Beijing SMEs during 2009 to 2013. However, the Shanghai SMEs on average filed more software copyright registrations than the Beijing SMEs. In the industry of petroleum and plastic manufacturing, the difference in the number of the filed patent applications between the SMEs from Beijing and Shanghai is statistically significant.

As Chapter 2, by the reasons that the Beijing SMEs and the Shanghai SMEs performed differently in R&D and patenting between 2009 and 2013, it is important to investigate the SMEs with the differences between the two cities.

3. Methodology

3.1. Panel Data Regressions

To explore the research questions in Section III, the models in this part keep utilizing the panel dataset in Chapter 2 with the above-presented variables and estimate a series of panel data models for them. This part introduces the design of the empirical models to test on the collected data. The sources of the firm-level data are from two different science parks, and the duration of the data is five years, from 2009 to 2013, covering at latest three years' data of the public SMEs before the IPO year.

Accordingly, the data are coded into five panel datasets for the difference between the two cities where they register and headquarter and the difference of their status of IPO. The panel datasets are constructed for the 82 and 58 enterprises and their general information in the market.

To explore the association among the three types of patent applications, R&D, issued patents and registered software copyrights in SMEs, and the strength of IP enforcement in China and the strictness of examination of the patent regime, following other studies that have tested for the impacts of R&D on patenting propensity,³⁵³ the OLS, random-effects or fixed-effects

³⁵³ Hall and Ham, *The Patent Paradox Revisited: Determinants of Patenting in the US Semiconductor Industry, 1980-94*.

models are estimated in one-way error component as the followings:³⁵⁴

$$Patent_{ift} = \alpha + \beta_1 R\&DI_{it} + \beta_2 R\&D_{it} + \beta_3 Court_t + \beta_4 AppealRate_t + \beta_5 PATENTIssue_{it} + \beta_6 Grant_{it} + \beta_7 Taxcredit_{it} + \beta_8 Employee_{it} + \beta_9 Industry_f + \mu_i + v_{it} \quad (1)$$

$$UM_{ift} = \alpha + \beta_1 R\&DI_{it} + \beta_2 R\&D_{it} + \beta_3 Court_t + \beta_4 AppealRate_t + \beta_5 PATENTIssue_{it} + \beta_6 Patent_{it} + \beta_7 Grant_{it} + \beta_8 Taxcredit_{it} + \beta_9 Employee_{it} + \beta_{10} Industry_f + \mu_i + v_{it} \quad (2)$$

$$Design_{ift} = \alpha + \beta_1 R\&DI_{it} + \beta_2 R\&D_{it} + \beta_3 Court_t + \beta_4 AppealRate_t + \beta_5 PATENTIssue_{it} + \beta_6 Patent_{it} + \beta_7 Grant_{it} + \beta_8 Taxcredit_{it} + \beta_9 Employee_{it} + \beta_{10} Industry_f + \mu_i + v_{it} \quad (3)$$

where $i \in I_1 = \{1, \dots, 410\}$, $I_2 = \{1, \dots, 290\}$, $I_3 = \{1, \dots, 700\}$, $f \in F = \{1, \dots, 14\}$ and $t \in T = \{2009, \dots, 2013\}$.

i denotes the individual SME. t denotes the year in which the SMEs innovate to apply and acquire patents, and f denotes the industry type. μ_i is an individual effect and varies across individual SMEs, but not across time. The remainder disturbance v_{it} denotes the residual varying with individuals and time. In different individuals or levels of time, α denotes the intercept and $\beta_1, \beta_2, \dots, \beta_{10}$ denote the slopes.

$R\&DI$ and $R\&D$ are the explanatory variables to signify the R&D intensity and the R&D investment amount. $Patent$, UM and $Design$ are the numbers of utility patent, utility model and designs patent filings. They are chosen to be dependent variables to capture the patenting propensity of SMEs. The number of patent application filings, $Patent$, is also controlled in model 2 and model 3 as an explanatory variable for tracking the consistency of patenting behaviors of SMEs.

Section 1 introduces the models controlling for the IP enforcement by the numbers of preliminary injunctions and litigations. Since these two variables show multi-collinearity with the number of patent courts and the number of patent courts grows for the increased demand of

³⁵⁴ Shown by the regression results, the lagging effects of R&D intensity and R&D investment do not explain the patenting propensity better than their immediate effects, so the model designs finally do not include the lagging effects.

patent litigations, the number of patent courts can represent the strength of IP enforcement as the function of the other two variables. Accordingly, the models left with the number of patent courts (*Court*). *AppealRate* indicates the appeal rate of the patent applications by SIPO for the rejection to represent the strictness of examination of the patent regime. The two country-level variables only vary across time, the five years, but not across individual SMEs.

PATENTIssue representing the three types of issued patents in total in an SME from SIPO is another control variable to capture the effect of obtaining patents on the further patenting behaviors of the innovative SMEs. The total amount of government grants (*Grant*) and the total amount of various types of tax credits (*Taxcredit*) are also added as control variables to capture the government intervention into the SMEs' patenting behaviors other than the IP regime. Those data resources and data description have been introduced in Chapter 2.

The other variables representing individual firm's characteristics and time are also included as control variables. The number of employees (*Employee*) surrogates for the size of the SMEs. *Industry* is a dummy variable to control for the category of industries where an SME is, so it only varies across individuals, but not across time. The categories of industry have been introduced in Chapter 2.

To explore the efficiency of IP commercialization among the SMEs, the models are estimated in one-way error component as the followings:

$$\begin{aligned}
 Revenue_{ift} = & \alpha + \beta_1 R\&DI_{it} + \beta_2 PatentIssue_{it} + \beta_3 UMIssue_{it} + \beta_4 DesignIssue_{it} \\
 & + \beta_5 Copyright_{it} + \beta_6 PatentIssue_{it-1} + \beta_7 UMIssue_{it-1} \\
 & + \beta_8 DesignIssue_{it-1} + \beta_9 Copyright_{it-1} + \beta_{10} PatentIssue_{it-2} \\
 & + \beta_{11} UMIssue_{it-2} + \beta_{12} DesignIssue_{it-2} + \beta_{13} Copyright_{it-2} \\
 & + \beta_{14} AppealRate_t + \beta_{15} Grant_{it} + \beta_{16} Taxcredit_{it} + \beta_{17} Employee_{it} \\
 & + \beta_{18} Industry_f + \mu_i + v_{it} \quad (4)
 \end{aligned}$$

$$\begin{aligned}
Netprofit_{ift} = & \alpha + \beta_1 R\&DI_{it} + \beta_2 PatentIssue_{it} + \beta_3 UMIssue_{it} + \beta_4 DesignIssue_{it} \\
& + \beta_5 Copyright_{it} + \beta_6 PatentIssue_{it-1} + \beta_7 UMIssue_{it-1} \\
& + \beta_8 DesignIssue_{it-1} + \beta_9 Copyright_{it-1} + \beta_{10} PatentIssue_{it-2} \\
& + \beta_{11} UMIssue_{it-2} + \beta_{12} DesignIssue_{it-2} + \beta_{13} Copyright_{it-2} \\
& + \beta_{14} AppealRate_t + \beta_{15} Grant_{it} + \beta_{16} Taxcredit_{it} + 17 Employee_{it} \\
& + \beta_{18} Industry_f + \mu_i + v_{it} \quad (5)
\end{aligned}$$

$$\begin{aligned}
AssetTR_{ift} = & \alpha + \beta_1 R\&DI_{it} + \beta_2 PatentIssue_{it} + \beta_3 UMIssue_{it} + \beta_4 DesignIssue_{it} \\
& + \beta_5 Copyright_{it} + \beta_6 PatentIssue_{it-1} + \beta_7 UMIssue_{it-1} \\
& + \beta_8 DesignIssue_{it-1} + \beta_9 Copyright_{it-1} + \beta_{10} PatentIssue_{it-2} \\
& + \beta_{11} UMIssue_{it-2} + \beta_{12} DesignIssue_{it-2} + \beta_{13} Copyright_{it-2} \\
& + \beta_{14} AppealRate_t + \beta_{15} Grant_{it} + \beta_{16} Taxcredit_{it} + 17 Employee_{it} \\
& + \beta_{18} Industry_f + \mu_i + v_{it} \quad (6)
\end{aligned}$$

where $i \in I_1 = \{1, \dots, 410\}$, $I_2 = \{1, \dots, 290\}$, $I_3 = \{1, \dots, 700\}$, $f \in F = \{1, \dots, 14\}$ and $t \in T = \{2009, \dots, 2013\}$.

Revenue (*Revenue*), net profit (*Netprofit*) and asset turnover ratio (*AssetTR*) of the SME are chosen as the dependent variables to capture the performance and competitiveness in the market by the SME. Asset turnover ratio of the SME is measured as a ratio of asset over employee. Also, asset turnover ratio of an SME can be measured as a ratio that capital intensity is divided by one. Capital intensity of an SME is a measure usually used by prior literature.³⁵⁵

PatentIssue, *UMIssue*, *DesignIssue* and *Copyright* are the explanatory variables, indicating the number of issued utility patents, utility models design patents that an SME acquires from SIPO and the number of registered software copyrights. Their one-year and two-year lagging effects are also controlled in the models as the explanatory variables, since the term of patent and copyright protection lasts over two years and IPRs should bring benefits to the SME during the term. The models also add a dummy variable as a control to categorize the SMEs acquired issued utility patents from SIPO or not, since most of the SMEs cannot annually acquire issued utility patents from SIPO.

The other variables representing individual firm's characteristics and time are also included

³⁵⁵ Hall and Ziedonis, "The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995."

as the control variables, including the R&D intensity ($R\&DI$), the total amount of government grants ($Grant$) and the total amount of various types of tax credits ($Taxcredit$).

Beyond model 6, the interaction between the number of issued utility patents from SIPO ($PatentIssue$) and the appeal rate ($AppealRate$) is also controlled in a product-term model because the appeal rate could affect the number of the issued utility patents from SIPO.

To explore the association between the SMEs' patenting behaviors and the government funding or subsidizes that they acquired, the models are estimated in one-way error component as the followings:

$$Patent_{ift} = \alpha + \beta_1 PatentSubsidy_{it} + \beta_2 R\&DI_{it} + \beta_3 R\&D_{it} + \beta_4 Court_t + \beta_5 AppealRate_t + \beta_6 TotalPatent_t + \beta_7 Revenue_{it} + \beta_8 Employee_{it} + \beta_9 Industry_f + \mu_i + v_{it} \quad (7)$$

$$UM_{ift} = \alpha + \beta_1 PatentSubsidy_{it} + \beta_2 Patent_{it} + \beta_3 R\&DI_{it} + \beta_4 R\&D_{it} + \beta_5 Court_t + \beta_6 AppealRate_t + \beta_7 TotalPatent_t + \beta_8 Revenue_{it} + \beta_9 Employee_{it} + \beta_{10} Industry_f + \mu_i + v_{it} \quad (8)$$

$$Design_{ift} = \alpha + \beta_1 PatentSubsidy_{it} + \beta_2 Patent_{it} + \beta_3 R\&DI_{it} + \beta_4 R\&D_{it} + \beta_5 Court_t + \beta_6 AppealRate_t + \beta_7 TotalPatent_t + \beta_8 Revenue_{it} + \beta_9 Employee_{it} + \beta_{10} Industry_f + \mu_i + v_{it} \quad (9)$$

where $i \in I_1 = \{1, \dots, 642\}, I_2 = \{1, \dots, 193\}$, $f \in F = \{1, \dots, 14\}$ and $t \in T = \{2009, \dots, 2013\}$.

The amount of the subsidies for patenting ($PatentSubsidy$) is an explanatory variable to indicate a direct government intervention in patenting behaviors of the SMEs under the goal of pro-patenting. Since the pro-patenting policy should be relevant to the development of the patent market in China, the total number of utility patent application filings ($TotalPatent$) is added as a control variable in the models. It only varies across the five years, from 2009 to 2013, but not across the individual SMEs.

3.2. Difference-in-Difference-in-Difference Specifications

In 2012, there was one policy change regarding patent subsidies in Shanghai.³⁵⁶ By contrast, during 2009 to 2013, the Beijing government adopts one identical patent subsidy policy to administer the patent applicants living or being registered in Beijing. Accordingly, in order to explore how the patent subsidy policies impact on SMEs' efficiency of commercializing patents, this part utilizes difference-in-difference-in-difference regressions. The regressions adopt 2012 as the intervention year to capture the responses of the amendment of the Shanghai patent subsidy policy on the market performance of the SMEs. The group of Beijing is adopted as the control group and the group of Shanghai is adopted as the treated group. The regressions compare the effects of their utility patents on improving the revenue of the SMEs and are designed as the followings:

$$\begin{aligned}
 Revenue_{iftct1} = & \\
 & \alpha + \beta_1 Change_{t1} + \beta_2 Group_c + \beta_3 (Change_{t1} * Group_c) + \beta_4 PatentIssue_{it} \\
 & + \beta_5 UMIssue_{it} + \beta_6 DesignIssue_{it} + \beta_7 (Change_{t1} * PatentIssue_{it}) \\
 & + \beta_8 (Group_c * PatentIssue_{it}) + \beta_9 (Change_{t1} * Group_c * PatentIssue_{it}) \\
 & + \beta_{10} Employee_{it} + \beta_{11} Industry_f + \mu_i + v_{it} \quad (10)
 \end{aligned}$$

where $i \in I_1 = \{1, \dots, 410\}$, $I_2 = \{1, \dots, 290\}$, $I_3 = \{1, \dots, 700\}$, $f \in F = \{1, \dots, 14\}$, $t1 \in T_1 = \{1, 2\}$, $c \in C = \{1, 2\}$ and $t \in T = \{2009, \dots, 2013\}$.

Category fixed effects and the time horizon fixed effects representing the policy change are specified as $Change_{t1}$ and $Group_c$. $UMIssue$ and $DesignIssue$ are control variables to capture the two forms of patents acquired by the SMEs from SIPO, other than utility patents. The coefficient of the three-way interaction, β_9 , surrogates for the diff-in-diff-in-diff effect.

³⁵⁶ Shanghai Shi Zhishi Chanquan Ju(上海市知识产权局)[Shanghai Intellectual Property Administration], *Shanghai Shi Zhishi Chanquan Fazhan "Shierwu" Guihua*(上海市知识产权发展“十二五”规划)[The Shanghai's "Twelveth Five-Year" Plan on Intellectual Property Development], 2012, accessed June 21, 2016, <http://www.sipa.gov.cn/gb/zscq/node2/node25/userobject1ai9309.html>.

V. Results and Implications

Implication 1: There is a positive relationship among all industries between the increase of R&D investment amount and the strength of propensity of SMEs on utility patents, shown by their utility patent applications, even though some innovation-intensive SMEs do not file any utility patent applications.

Overall, in the estimation to predict utility patent propensity, shown in model 7 of Table 3.1, the coefficient on R&D investment by SMEs is statistical significant and positive, suggesting that the SMEs file on average 5.32 more utility patents when their R&D investments are increased by ¥10,000 RMB and R&D intensity, employee size, and the strictness on patent examination are held as constant at their average level. On the other side, when focusing on the effects of R&D intensity on utility patent propensity and holding R&D investment and the other factors as constant at their average level, the coefficient on R&D intensity also yields a statistically significant and positive result, suggesting that R&D intensity has a positive effects on the increase of SME' propensity on utility patents. Because the industry category is held as constant in the estimation, the positive trend between R&D, represented by R&D intensity and R&D investment, and the propensity of SMEs on utility patents remains as consistent among all industries.

Those results, however, are not consistent in the estimations with different panels of samples, shown by model 1, model 4 and model 7 of Table 3.1. If we look into the two groups of Beijing and Shanghai, the significant positive effects of R&D investment and R&D intensity on improving utility patent propensity only remains in the results of the random-effect GLS estimation with the Beijing's panel.

By contrast, in model 4 in Table 3.1, the fixed-effect model that is selected by Hausman test

and to estimate utility patent propensity with the Shanghai's panel, the coefficients on the two factors are insignificant, even though they are statistically significant correlated with the increase of utility patent propensity ($r=0.15$ in R&D investment, $r=0.21$ in R&D intensity). Meanwhile, the fixed-effect model cannot control for industry categories, which is time-invariant. While the model passes the F-test, the coefficients may suggest that there is another significant fixed effect, which is the bias in an estimation with fixed effects least squares, also known as least squares dummy variable (LVDS).

The Shanghai SMEs on average have weaker incentives to apply for utility patents in a statistically significant degree compared to the group of Beijing SMEs, shown by the t-test. The estimation in model 2 of Table 3.2 adopts random effects least squares and excludes the Shanghai SMEs which did not file utility patent applications. Under this estimation, the coefficient on R&D investment yields a statistical significant result, suggesting a positive effect of R&D investment on the propensity of the SMEs on utility patents when controlling for industry category as fixed and holding R&D intensity as constant. In other words, regardless of R&D intensity, R&D investment alone has a significant positive effect on improving utility patent propensity of SMEs among all industries.

The Beijing samples' story is consistent with Shanghai's. While the coefficient on R&D intensity in model 1 of Table 3.1 yields a statistically significant result, the statistical significance of the coefficient is weak ($p<0.1$). The estimation in model 1 of Table 3.2 excludes the Shanghai SMEs which did not file utility patent applications and the coefficient on R&D intensity turns to be insignificant, even though the coefficient on R&D investment remains a statistical significant and positive result.

Across the estimations with the three panels, the value of the coefficients on R&D investment is close, suggesting that the effects of R&D investment on improving the propensity of SMEs on utility patents are positive in an even degree regardless of geographic differences. The limitation is that it is difficult to estimate the degree of the exact effects, because the coefficients on R&D intensity involving R&D investment amount are insignificant.

In Table 3.7, the coefficients on R&D investment to predict the filings of utility patent application yield statistically significant and positive results. The coefficient for the panel before IPO is larger than the coefficient for the panel after IPO in a statistically significant degree of 95%. Those results suggest that the positive association between R&D investment and utility patent applications is stronger among the SMEs before IPO than after.

Therefore and overall, the strength of propensity of SMEs on utility patents could be an effective factor for governments or investors to evaluate or monitor the level of R&D investment by an SME other than its R&D investment amount. The strength is especially strong before IPO when limited disclosed information is acquainted with an SME, regardless of the size and the industry category of the SMEs.

Implication 2: The utility patent propensity of SMEs is consistent with their propensity on utility models, but lower than their propensity on utility patents. Innovation-intensive SMEs have a significantly lower propensity on utility models.

In Table 3.1, model 2, model 4 and model 8 are the estimations to predict the propensity of the SMEs on utility models. Consistently in the three models, when industry category is controlled as a fixed effect, the coefficients on R&D intensity yield a statistically significant and negative result, suggesting that the increase of R&D intensity of the SMEs varies with a decrease of utility model applications. In other words, when R&D intensity of SMEs is higher, their propensity on utility models is lower.

On the other hand, in those three models, the coefficients on utility patent propensity of SMEs yield statistically significant and positive results, suggesting a uniform variation of the propensity of the SMEs on utility patents and utility models. As the results shown by the overall panel samples, when an SME files one more utility patent, it files 0.35 more utility models simultaneously, which is less than 1. Meanwhile, the coefficients on the utility model propensity of the SMEs equal to 0.33 and 0.60 for the groups of Beijing and Shanghai, respectively. Both of

them are also lower than 1, suggesting that the SMEs on average have a higher propensity on utility patents compared to their propensity on utility models. When the SMEs got an outcome of their innovation and demanded an IP protection for that, they prefer to pursue the protection under utility patents rather than utility models, even though an application for utility models without a substantive examination is cheaper, quicker and easier than a utility patent application.

The previous analyses conclude that a significant positive relationship between R&D investment amount and utility patent propensity and a low propensity of innovation-intensive SMEs on utility models. Accordingly, the estimations to predict utility model propensity with the predictor of utility patent propensity suggest that the SMEs actively conducting R&D prefer to apply for utility patents than utility models for their innovation outcomes.

In addition, even though the dual-application is allowed, which means that an applicant can file a utility patent application and a utility model application for a same piece of technology, the SMEs do not really file a dual-application for their innovation and technology. One possibility is that they do not make appropriate patent strategies, so they cannot realize utility models as a bottom for their utility patent applications. Another possibility is that they on average file more utility patents for methods, which are not protected under utility models. Because I did not control for the subject matter of the utility models, so there is a limitation to make this statement. However, the SMEs hardly make incomes from patent licensing, which means that they usually use the patents for their own. If they only use the patents negatively, they have not realized the higher costs of enforcing a method patent rather than a product patent, which also suggest that they do not make appropriate patent strategies.

An alternative possibility is that SMEs make patent strategies. They value the stronger protection under utility patents more than the weaker protection under utility models for their innovation and technology, and they do not want to waste the application fee to apply for utility models. Governments, lenders and investors may value utility patents more than utility models to decide to fund them so the SMEs may make patent strategies in the perspectives on attracting external financing. However, learning from the overall research, this is not the happening story

in this case.

Implication 3: Net profit of SMEs is associated with the variation of their issued utility patents and utility models.

Implication 3.1: The effect of issued utility models on the variation of net profit is not through their effects on directly or indirectly generating revenue, and the immediate effect is weaker compared to the effect of issued utility patents on improving net profit.

In the estimations to predict net profit, shown by model 3, the model 6, and model 9 in Table 3.3, the coefficients on issued utility models and the lagged issued utility models show statistical significance, but only in certain circumstances. For the overall group, the coefficients on issued utility models and one-year lagged issued utility models yield statistically significant results. However, the value of the coefficients is opposite, suggesting that the effects of issued utility models in a long term and in a short term are opposite. The coefficient on issued utility models is negative, and the coefficient on issued utility models lagged by one year is positive and bigger. Therefore, the accumulated effects of issued utility models on improving net profit is positive. While the positive effect of issued utility models on improving net profit is lagged, lagged issued utility models cannot contribute to directly improve revenue, so the positive effect on improving net profit could not be realized through revenue.

For the group of Beijing, the accumulated effects of issued utility models on improving net profit is also positive. In detail, the coefficient on issued utility models lagged by one year yields a statistically significant and positive result, but the coefficient on issued utility models suggests that the immediate effect of issued utility models is insignificant. On the other side, in model 1 of Table 3.3, the coefficient on issued utility models yields a statistically significant and positive result, suggesting that issued utility models have a positive effect on immediately improving revenue, but it is not clear about their lagged effects on improving revenue. Therefore, this

circumstance is consistent with the overall panel's result that the positive effect of issued utility models on net profit is not realized through its positive effect on directly generating revenue.

For the group of Shanghai, the coefficient on issued utility models lagged by two years yields a statistically significant and negative result, suggesting that the lagged effect of issued utility models is negative on improving net profit of the SMEs. In this case, issued utility models not only cannot improve net profit, but also have a negative effect on improving net profit. Meanwhile, the coefficient on issued utility models is insignificant to predict revenue, shown by model 4 of Table 3.3. Therefore, it is unclear how the negative effect of issued utility models on improving net profit through their direct effects on revenue.

On the other hand, the estimations to predict asset turnover ratio, shown by model 2, model 5 and model 8, come out with insignificant coefficients on issued utility models, suggesting that it is unclear how utility models affect the efficiency of deploying total assets of the SMEs in generating revenue when their R&D intensity is hold as constant in its average degree. In other words, it is unclear how utility models are utilized by the SMEs inside their business running and combined with these processes, such as their management and production. Therefore, the effect of issued utility models on the variation of net profit is also not through their indirect effects on generating revenue.

Compared to the effects of utility models on net profit, in model 3, model 6 and model 9 in Table 3.3, the coefficients on issued patents yield statistically significant and positive results, and are higher than the coefficients on one-year lagged issued utility models, which is the positive effect of utility models contribute to the increase of net profit of the SMEs. On the other hand, the estimation with the overall samples suggests that issued utility patents have a lagged but negative effect on improving net profit. The positive coefficient on issued utility patents is lower than the negative coefficient on issued utility patents lagged by one year, so the sum of the coefficients suggests that the overall effects of utility patents on improving net profit is negative.

Viewing the immediate effects of issued utility patents and issued utility models on improving net profit, however, the coefficient on issued utility patents is positive and three times

larger than the negative value of the coefficient on issued utility models, suggesting that utility patents have a stronger positive effect on improving net profit shortly compared to utility models. If we look into the two groups of samples, this result is consistent because only coefficients on issued utility patents yield statistically significant and positive results, rather than the results of the coefficients on issued utility models, shown by model 3, model 6 of Table 3.3. Overall, the effects of issued utility models on improving net profit of SMEs are weaker than the effects of issued utility patents.

Implication 3.2: Most SMEs could not efficiently deploy utility patents and transform them into revenue. Even worse, too many issued utility patents could impede SMEs on their business running, reflected by the revenue, net profit or asset turnover ratio, especially when the strictness of patent examination is higher.

With the overall panel's samples in model 7 of Table 3.3 to predict revenue, the coefficient on issued utility patents is not statistically significant, suggesting an insignificant effect of issued utility patents on generating revenue. Therefore, even though the coefficients on issued utility patents are statistically significant and positive in the estimations to predict net profit, shown by model 3, model 6 and model 9 in Table 3.3, the positive effect of utility patents on improving net profit is not through generating revenue.

Furthermore, not only can utility patent not be proved to contribute to the increase of revenue of the SMEs either in a short term or in a long term, but utility patents also cannot effectively improve the net profit of the SMEs. The overall value of the coefficients on the issued utility patents in the ongoing year and the utility patents issued one year ago is negative, suggesting that accumulated utility patents have significantly negative effect on the increase of net profit of the SMEs, shown by model 9 of Table 3.3. Net profit could decrease ¥468,000 RMB when an SME acquired one more utility patent issued in the previous year and acquired one more issued utility patent in the current year. In other words, when an SME consistently

acquired more utility patents than other SMEs, it may not have the capability to manage the accumulated utility patents efficiently and transform them into net profit through generating revenue. Not only were the SMEs poor at utility patent commercialization, but the utility patents may also impede their business running. Moreover, it is a phenomenon across all industries because the estimations have controlled for industry categories as fixed.

If we take a look into the two cities' difference, it seems that Beijing SMEs have weaker capabilities of utility patent commercialization in order to transform issued utility patents into revenue and net profit than Shanghai SMEs do. For example, in the estimations to predict net profit, the coefficient on issued utility patents in model 3 with the Beijing panel is significantly lower than the coefficient in model 6 with the Shanghai panel. On average, a Shanghai SME issued with one more utility patent in a year acquires ¥1,862,000 RMB more on net profit than a Beijing SME does, shown by model 3 and model 6 of Table 2. On the other side, the coefficients on issued utility patents in the estimations to predict revenue, shown by model 1 and model 4 of Table 3.3 yield inconsistent yet opposite results.

For the group of Shanghai, the estimation in model 4 suggests a positive effect of issued utility patents on improving revenue. When a Shanghai SME acquired one more issued utility patent, its revenue can be ¥24,670,000 RMB in that year. By contrast, for the group of Beijing with a bigger size of samples than the Shanghai's group, the estimation in model 1 suggests a negative effect of issued utility patents on improving revenue. When a Beijing SME acquired one more issued utility patent in a year, its revenue decreased by ¥4,265,000 RMB.

According to the opposite effects of utility patents on improving revenue between the Beijing SMEs and the Shanghai SMEs, one possibility is that the ways or strategies in which the SMEs use utility models in their business activities could be significantly different. For example, the capabilities of Shanghai SMEs to transform utility patents to more revenue are comparatively stronger than the capabilities of Beijing SMEs. This is a consistent result with their stronger effect of utility patents on improving net profit than Beijing SMEs'.

Unfortunately, under the patent strategies of the SMEs, overall, the effectiveness of their

capabilities in transforming utility patents to more revenue is still weak. The issued utility patents lagged one or two years cannot contribute to the increase of revenue in a statistically significant degree, shown by the estimations to predict revenue in model 1 and model 4 of Table 3.3. Meanwhile, the coefficients of the estimations to predict net profit on the lagged issued utility patents with the Beijing panel's and the Shanghai panel's samples are insignificant, shown by model 3 and model 6. These estimations suggest that it is unclear how the SMEs transform their utility patents issued in the previous years to revenue and net profit. While the correlation coefficient between utility patents issued two years ago and the current revenue yields statistically significant and positive result, the statistical significance does not remain when the other significant types of IPRs, such as utility models, design patents and software copyrights, are controlled as constant, suggesting that the lagging effect of utility patents on improving net profit of the Shanghai SMEs is unclear when we assume the SMEs made IP strategies involving the IPRs other than solely utility patents.

Actually, SMEs do make IP strategies, at least for the Shanghai SMEs. However, under their IP strategies, the Shanghai SMEs may be still unable to transform utility patents to net profit, even though the coefficient on utility models yields a statistically significant and positive effect in the estimation to predict net profit. For the group of Shanghai, the correlation coefficient ($r=-0.02$) between issued utility patents and net profit suggests that they do not directly correlated in a statistically significant degree. However, when the estimation controls for the lagging effects of IPRs, including issued utility patents and issued utility models and registered software copyrights, shown by model 6 of Table 3.3, the effect of issued patents on improving net profit turns to be significantly positive, suggesting a positive effect of the accumulated IPRs acquired by the SMEs through their IP strategy.

On the other side, for both the group of Beijing and the group of Shanghai, in most of the time, the correlation coefficients between utility patents and revenue are going up (for the Shanghai group, $r = 0.193$, r of one-year lagged= 0.068 r of two-year lagged= 0.139 ; for the Beijing group, $r=0.075$, or of one-year lagged= 0.021 , r of two-year lagged= 0.002), even though

the degree of the correlation could not be as high enough as to be statistically significant. Therefore, it is difficult to believe that the SMEs can effectively transform their accumulated utility patents into revenue, because even their issued utility patents in the ongoing year could not provide strong effects on generating revenue, which is also suggested by the estimation with the overall panel's sample, shown by model 7 of Table 3.3.

If the effect of issued utility patents on improving net profit of the SMEs is not through effectively generating revenue, I am interested in how the issued utility patents are deployed with other tangible assets of the SMEs so as to affect the increase of their revenue and net profit. In the estimation to predict asset turnover ratio with the overall panel's samples, shown by model 8 of Table 3.3, the coefficient of issued utility patents yields a statistically significant and negative result, suggesting a negative effect of issued utility patents on improving asset turnover ratio. In other words, an SME on average holding more issued utility patents has a lower efficiency in deploying its asset in generating revenue.

This estimation is with fixed effects least squares; nevertheless, the industry categories cannot be controlled and it has a bias, suggesting another significant fixed effect other than issued utility patents. This released significant fixed effect could be industry categories because ANOVA testing the variance of asset turnover ratio is statistically significant across the various industry categories. While the bias is a limitation for clearly understanding the effect of issued utility patents on improving asset turnover ratio, when R&D intensity of the SMEs is controlled as constant in its average degree, the negative coefficient on issued utility patents suggests that the SMEs may not effectively deploy their total assets in generating revenue through acquiring more utility patents. In other words, the SMEs cannot effectively deploy their utility patents to adjust with other assets and finally improve net profit.

On the other hand, the estimations of asset turnover ratio in Table 3.4 have coefficients on the interaction term between issued utility patents and the strictness of patent examination, which is an instrument variable of issued utility patents and presented by the appeal rate of the utility patent applications, being statistically significant and negative. In the overall case, in the year

when the strictness of patent examination increases one unit, the slope of asset turnover ratio on issued utility patents decreases 0.598 units, shown by model 3. This result is consistent with the result of the estimation with the Beijing panel's samples.

Even though the coefficient on issued utility patents in model 2 of Table 3.4 with the Shanghai panel's samples yields a statistically significant and positive result, the coefficient on the interaction between the strictness of patent examination yields a negative result, and this negative value is bigger than the positive coefficient on issued utility patents. Involving the interaction effect, the coefficient on issued utility patents decreases to -0.064 when the strictness of patent examination increase is controlled as constant in its average level (0.14%), suggesting that when an SME acquires one more issued utility patent, its asset turnover ratio decreases by 0.064, and it has lower efficiency in deploying its total assets in generating revenue.

Overall, not only can the SMEs not effectively deploy their accumulated utility patents in generating revenue and net profit, but also these issued utility patents may directly and indirectly impede the efficiency of their business running and become their burdens. They lack the capabilities to efficiently manage their intangible assets and explore their value from commercializing them. Therefore, it is important to induce them to make efficient IP strategies, rather than blindly encourage them to produce more utility patents.

Implication 3.3: Design patents and software copyrights could be the encumbrance for the business running of SMEs, rather than making positive contributions to their net profit.

While the estimations suggest that the effects of design patents and software copyrights on improving revenue and asset turnover ratio are insignificant, shown by model 1, model 2, model 4, model 5, model 7, and model 8 of Table 3.3, most of the coefficients on issued design patents and registered software copyrights in the ongoing year, and lagged issued design patents and registered software copyrights yield statistically significant and negative results. In other words, when it is unclear how the SMEs deploy their design patents and software copyrights in

generating revenue directly or indirectly, they may become encumbrance for their business running and impede the increase of their net profit.

In the overall case, the coefficients on issued design patents in the ongoing year and issued design patents lagged by one year and two years present statistically significant and negative results, suggesting that the effect of issued design patents is consistently negative on improving net profit of the SMEs in either a short-term and a long-term.

For the group of Beijing, in model 3, the estimation to predict net profit suggests that the lagging effect of issued design patents is insignificant, and the immediate effect of issued design patents is negative on improving net profit of the SMEs in a statistically significant degree. By contrast, for the group of Shanghai in model 6, the estimation to predict net profit suggests that the immediate effect of issued design patents is insignificant, but the effects of issued design patents lagged by one year and two years are negative on improving net profit of the SMEs.

On the other hand, the estimations to predict net profit cannot clearly suggest how the registered copyrights affect net profit of the SMEs, shown by model 3, model 6 and model 9 of Table2. Only do the coefficients on the two-year lagged registered software copyrights yield statistically significant and negative result in the estimation to predict net profit with the overall samples and with the group of Beijing samples. Moreover, in the estimation with the group of Shanghai samples, the coefficients on registered copyrights in the ongoing year and lagged registered copyrights are insignificant, suggesting that the effects of registered software copyrights on improving net profit of the Shanghai SMEs are insignificant in both a short-term and a long-term. Therefore, registered software copyrights cannot effectively contribute to improving net profit of the SMEs.

According to the P.R.C. Copyright Law, software copyright registration is not a pre-condition to enforce copyrights in China. The most important reason for the SMEs to register for software copyrights is that they need to show the copyrights to the governments and acquire prizes, subsidies from the governments. For example, to be entitled as the key software companies for acquiring at least 15% corporate tax credits, the applicants need to have some

registered copyrights as the application material.³⁵⁷ Therefore, the SMEs may not only develop software as their products or management supports, but also accumulate software to acquire prizes and subsidies from the governments. The extra developed and registered software copyrights could waste some resources of the SMEs, but cannot effectively contribute to improving their revenue or net profit. Meanwhile, some accumulated but useless software could waste more resources of the SMEs in the process of their management so as to be encumbrance for their business running.

Since the governments are encouraging enterprises to acquire more IPRs, as a reflection, the SMEs acquire design patents, even though the designs are not their main products in their business. However, they do not have the capabilities to effectively transform the design patents into revenue or improve their net profit through the design patents. One possibility is that their IP strategies are inefficient, which is consistent with my previous implications. Therefore, it is not enough to only encourage SMEs to acquire more IPRs by the governments. Instead, the governments should induce SMEs to manage their IPRs efficiently and improve the commercialization of various types of IPRs, including software copyrights and design patents.

Implication 4: The pro-patent-quality policies applied in 2012 may not be suitable for SMEs to effectively improve their utility patent commercialization.

In the sense of the overall case, most SMEs could not efficiently deploy utility patents and transform them into revenue and too many issued utility patents could impede SMEs on improving revenue. However, for the Shanghai SMEs, they on average had stronger capabilities to transform utility patents into revenue compared to the Beijing SMEs, especially before the Chinese governments adjusted their policies on administrating IPRs in 2012. Therefore, the

³⁵⁷ Guojia Shuiwu Zongju(国家税务总局)[The P.R.C. State Administration of Taxation] and Zhonghua Renmin Gonghe Guo Caizheng Bu(中华人民共和国财政部)[The Ministry of Finance of the P.R.C.], *Guanyu Jinyibu Guli Ruanjian Chanye He Jicheng Dianlu Chanye Fazhan Qiye Suodeshui Zhengce De Tongzhi*[关于进一步鼓励软件产业和集成电路产业发展企业所得税政策的通知][*The Notice of Corporate Tax Policy for Further Encouraging the Development of the Industries of Software and Intergrated*].

governments may meddling serve the SMEs' utility patent commercialization through the pro-patent-quality subsidies based on the discriminated standards.

● The Shanghai Patent Subsidy Policy Change in 2012

In 2012, for executing the twelfth Five-Year Plan, the central government and the two local governments designed a series of new policies on strengthening the IP regime.³⁵⁸ Before 2012, the Beijing government had applied the policies on strengthening the capabilities of IP commercialization by enterprises and encouraging them to acquire more IPRs through subsidies and prizes.³⁵⁹ After 2012, the Beijing government decided to involve their guidance more in the IP activities of the Beijing enterprises. Not only did it explore the administration methods on the process of recognizing IP as collateral, it sustained to encourage the enterprises, especially SMEs, to acquire more IPRs through increasing the subsidies for patent applications and services, and to strengthen their capabilities of IP commercialization.

On the other side, before 2012, the Shanghai government had applied the policies on recognizing IP as collateral and subsidizing IP applications.³⁶⁰ After 2012, under the guidance of the central government's policy on strengthening the IP regime, like the Beijing government, the Shanghai government decided to involve their guidance more in the innovation by the Shanghai

³⁵⁸ Zhongguo Guojia Zhishi Chanquan Ju(中国国家知识产权局)[State Intellectual Property Office of the P.R.C.], "Guojia Zhishi Chanquan Shiye Fazhan 'Shierwu' Guihua-Yaodian Jiedu(《国家知识产权事业发展'十二五'规划》要点解读)[The Key Explanation of the National IP Career Development in the 'Twelveth Five-Year' Plan]," *State Intellectual Property Office of the P.R.C.*, 2012, accessed June 21, 2016, http://www.sipo.gov.cn/zcfg/zcjd/201310/t20131025_863255.html.

³⁵⁹ Beijing Shi Zhishi Chanquan Ju(北京市知识产权局)[Beijing Intellectual Property Office] and Beijing Shi Fagaiwei(北京市发改委)[Beijing Municipal Commission of Development and Reform], *Beijing Shi "Shierwu" Shiqi Zhishi Chanquan (Zhuanli) Shiye Fazhan Guihua(北京市“十二五”时期知识产权(专利)事业发展规划)[Beijing's Plan on IP-Patent Career Development in the "Twelveth Five-Year"]*, 2011, accessed June 21, 2016, <http://zhengwu.beijing.gov.cn/ghxx/sewgh/t1221565.htm>. Also see, Beijing Shi Zhishi Chanquan Ju(北京市知识产权局)[Beijing Intellectual Property Office] and Beijing Shi Fagaiwei(北京市发改委)[Beijing Municipal Commission of Development and Reform], *Guanyu Yinfa 《Beijing Shi "Shierwu" Shiqi Zhishi Chanquan (Zhuanli) Shiye Fazhan Guihua》 De Tongzhi (关于印发《北京市“十二五”时期知识产权(专利)事业发展规划》的通知)[The Notice About Printing and Distributing <Beijing's Plan on IP-Patent Career Development in the "Twelveth Five-Year">]*, 2012, accessed June 21, 2016, http://www.bjipo.gov.cn/zcfg/zlgh/201202/t20120207_25714.html.

³⁶⁰ Shanghai Shi Zhishi Chanquan Ju(上海市知识产权局)[Shanghai Intellectual Property Administration], *Shanghai Shi Zhishi Chanquan Fazhan "Shierwu" Guihua(上海市知识产权发展“十二五”规划)[The Shanghai's "Twelveth Five-Year" Plan on Intellectual Property Development]*.

enterprises. For example, the government planned to improve the degree of R&D investment over GDP, increase the subsidies and prizes for IPs and inventions, and induce the Shanghai enterprises to acquire more IPRs.

Beyond the enhanced encouragement of acquiring more IPRs by enterprises, in the process of involving their IP activities, both governments would gather the IPRs across different IP owners and structure IP alliances. However, the real goal behind that is to induce the production of patents in high quality.

After 2012, the amount of the subsidies provided by the Shanghai government for each of the patent applications is less, especially the subsidy for utility models and design patents.³⁶¹ However, under the new policy, the patent subsidy will offset part costs of patent prosecution and offset more PCT's fees compared to the earlier edition of the pro-patent policy executed in 2007.³⁶²

● The Beijing Patent Subsidy Policy

Compared to the Shanghai patent subsidy policy, the Beijing patent subsidy policy is discriminated for the patent applicants and always designed for promoting the quality of patents. Some parts of the policy is more relaxed than the Shanghai's, but parts of the policy is more restricted than the Shanghai's. More precisely, only the big and middle sized research institutes or enterprises' patent application costs could be fully offset. For those patent applicants, the scope and the extent of the subsidy is exactly the same as the 2007's Shanghai patent subsidy policy. If the small firms request for the subsidy, they have to be consistently conducting

³⁶¹ Shanghai Shi Zhishi Chanquan Ju(上海市知识产权局)[Shanghai Intellectual Property Administration], *Shanghai Shi Zhuanli Zizhu Banfa (2012 Xiuding)*(上海市专利资助办法(2012 修订))[*The Methods of the Shanghai Patent Subsidies (Amended in 2012)*], 2012, accessed June 21, 2016, <http://www.lungtin.com/content/2011/11-08/145150051.html>.

³⁶² Shanghai Shi Zhishi Chanquan Ju(上海市知识产权局)[Shanghai Intellectual Property Administration], *Shanghai Shi Zhuanli Zizhu Banfa (Fu Shishi Xize)* (2007 Nian 3 Yue 1 Ri Fabu)(上海市专利资助办法(附实施细则)(2007 年 3 月 1 日发布))[*The Methods of the Shanghai Patent Subsidies (Application Details Attached)*](Published in Mar. 1st, 2007)], 2007.

innovation and filing patent applications for at least three years.³⁶³ In addition, the Beijing government requires that the applicants for the subsidy should have at least three people managing their IP and regularly train their R&D people on IP knowledge. Their R&D over net profit ratio and the size of their market should also be higher than the average level in the market. Otherwise, only half of the substantial examination fee could be offset by the subsidy, and the utility patents and design patents' application cost could be offset as one fourth of the other heavily subsidized firms in Beijing, which is also lower than the firms in Shanghai.

Therefore, overall, compared to the Shanghai patent subsidy policy, the extent of the subsidy for the Beijing SMEs is polarized into two situations, expected to strongly support the patents with high quality. Only a few of SMEs in my samples are entitled to the full subsidy. This shows a paradox in the Beijing's pro-patent policies. On the one side, the government announces that it is going to help SMEs to conduct patent activities; on the other side, the government is strongly helping the firms and research institutes, which are voluntarily doing well in IP area.

● Diff-in-Diff-in-Diff Estimations to Compare the Effects of the Two Policies

To explore the variance of the efficiency of those policies on improving the capabilities of utility patent commercialization by SMEs, I adopt difference-in-difference-in-difference estimations, shown in Table 3.5.

Being consistent with the results of the estimations in model 1 and model 4 of Table 3.3, the estimation shown by model 1 of Table 3.5 suggests that the Shanghai SMEs on average have higher efficiency in improving revenue through issued utility patents than the Beijing SMEs, and the efficiency of the overall SMEs on average decreases after 2012. Both of the differences of area and the interventions are in a statistically significant degree, suggested by the coefficients

³⁶³ Beijing Kewei(北京科委)[Beijing Municipal Commission of Science and Technology], <Beijing Shi Zhuanli Shenqing Zizhu Jin Guanli Zanzheng Banfa>Jiedu(《北京市专利申请资助资金管理暂行办法》解读)[The Explanation of <The Temporary Methods of Administrating Beijing Patent Application Subsidies>], 2007, accessed June 21, 2016, <http://www.bjkw.gov.cn/n8785584/n8904761/n8904840/n9128829/9128992.html>.

on the interaction term between issued utility patents and the dummy variable controlling for the Shanghai group, and the interaction term between issued utility patents and the dummy variable controlling for the year after 2012.

If we look into those two differences, shown by model 2 and model 3 of Table 3.5, the coefficients on the interaction term among issued utility patents, the group of Shanghai and the time before 2012 yield statistically significant and positive results, suggesting that the efficiency of issued utility patents deployed by the Shanghai SMEs on generating revenue before 2012 is higher than their efficiency after 2012 and also the Beijing SMEs' efficiency of issued utility patents in generating revenue.

At Figure 3.2, the graphs show the slopes of revenue on issued utility patents. The slopes representing the regression returned by the Shanghai's group are always higher than the slopes representing the regression returned by the Beijing's group, suggesting that before and after 2012 the Shanghai SMEs that acquired same number of utility patents as the Beijing SMEs could generate more revenue than the Beijing SMEs. The slopes in the 2009-2011 graph as the controlled groups for the effects of the 2012 policies in the two cities are higher than the slopes in the 2012-2013 graph as the treated groups, suggesting that after 2012 the increase of issued utility patents in both the Beijing SMEs and the Shanghai SMEs has less effect on generating revenue.

Overall, the Shanghai SMEs can deploy their issued utility patents more efficiently on generating revenue than the Beijing SMEs, but the strength of the efficiency was weaker in 2012, when the new pro-policies were applied. Moreover, after 2012, the SMEs' capabilities of utility patent commercialization became weaker, even for the Shanghai SMEs, whose capabilities of utility patent commercialization was always stronger than the Beijing SMEs from 2009 to 2013.

Alternatively, another diff-in-diff-in-diff regression to explore the difference between Beijing and Shanghai's SMEs' efficiency of transforming issued utility patents into revenue is shown by Table 3.6. Since there was a patent subsidy policy change only in Shanghai in 2012, the regression adopts the samples before 2012 as the control group, and the samples after 2012 as

the treated group.

The diff-in-diff-in-diff effect of the 2012 patent subsidy policy change in Shanghai shows a slightly statistically significant and negative difference result. Before 2012, the coefficient on issued utility patents of the Shanghai SMEs to estimate revenue yields a statistically significant and positive result when the regression controls issued utility models and registered copyrights as constant in their average degree (mean of issued utility models= 2.56, mean of registered copyrights= 3.08), suggesting that there is a positive association between the issued utility patents and revenue. However, the statistically insignificant coefficient on issued utility patents of the Beijing SMEs cannot suggest the association to resemble the Shanghai SMEs' case.

On the other hand, the difference between the coefficients on issued utility patents to estimate revenue with the Shanghai and the Beijing panels yields a statistically significant result, suggesting that the Shanghai SMEs' issued utility patents have stronger positive association with revenue than the Beijing SMEs'. In other words, the Shanghai SMEs on average have a stronger ability to transform their issued utility patents into revenue than the Beijing SMEs. However, after 2012, their ability on utility patent commercialization became weaker so that their issued utility patents' effect on improving revenue became insignificant, and there was no more difference between their utility patent commercialization ability and the Beijing SMEs'.

The difference between the coefficients before and after the policy change in Shanghai yields a statistically significant and negative result with the Shanghai panel, suggesting that the positive association between Shanghai SMEs' issued utility patents and generating revenue became weaker after the policy change.

At Figure 3.3, the slope of revenue on issued utility patents in the side of Shanghai panel is lower after the policy change, and they became identical with the Beijing SMEs. Of course, the increased constants after 2012 suggest that the SMEs in the two cities on average had higher degree of revenue, but it could be affected by the growth of the economy or other reason. In short, pro-patent policies applied in 2012 may not be suitable for SMEs to effectively improve their utility patent commercialization, even though improving SMEs' patent commercialization is also

one of the goals of having patent subsidy.

- The Inefficacy of the Ex Post Patent Subsidy Policies

Probably, when the governments decide to involve in the IP activities of enterprises for public interests, such as improving the quality of the innovation in the market, encouraging IP transformation for particular projects, or constructing IP alliances, the interests of SMEs could be disregarded or not be treated properly. In addition, the alternative explanation could be that an ex post policy cannot instruct the nature of the quality of the innovation and the employment of patents in SMEs.

The patent subsidy policy seems as ex ante because the government subsidizes the patent applicants before their patents get issued, but actually, it is still ex post. The patent applicants have to show the evidence to support the value and creativity of their patents from the market ahead or they have to foresee a light future of their patents globally, then can request as much as subsidy from the government. Therefore, for patent applicants, patent subsidy is endogenous but ex post. They have to make clear patent strategies ahead, like how to deploy their patents in their management and market development, and then file patent applicants and request the patent subsidy from the government. In this process, the subsidy policy cannot really facilitate the SMEs to make efficient patent strategies.

To further prove the robustness of this conclusion, the regressions in Table 3.7 are based on a division with respect to the status of IPO. Among the SMEs after IPO, the coefficients on patent application fee's subsidy to predict the number of utility patent filings and design patent filings yield statistically significant and positive results, suggesting that there are positive correlations between patent subsidy and the number of utility patent applications or design patent applications. By contrast, shown by the insignificant coefficient on the subsidy, the effects of patent subsidy on improving the three types of patent applications are insignificant before IPO, even though the p-values of the difference between the coefficients on patent subsidy for the two

groups, before and after IPO, are consistently too high to be statistically significant.

As an endogenous effect, acquiring patent subsidy is part of the patent strategy of the SMEs when they are applying for patents. When they are not as successful as the public SMEs, the maximum amount of the patent subsidies that they can acquire from the government is lower than the public SMEs who have relatively maturer patent strategies.

In Table 3.7, the coefficients on revenue to estimate the filings of utility patent applications yield statistically significant results. However, the association between utility patent applications and revenue among the SMEs after IPO is opposite to the association among the SMEs before IPO with a statistically significant degree of 90%. The p-value of the t-test of the difference between two coefficients is 0.062. Among the SMEs after IPO, the association is positive, suggesting that the SMEs file for more utility patent applications when they grow larger. By contrast, before IPO, the association is negative, suggesting that the SMEs file for more utility patent applications even when they generate less revenue than the other SMEs or themselves in the other years. To some extent, the patent strategy of the SMEs before IPO could be comparatively immature than the SMEs after IPO.

Here, patent subsidy could not significantly affect the patent strategy employed by those private SMEs to file more of the three types of patent applications or not, especially when the patent subsidies are not substantial for them. However, when the public SMEs are more capable on voluntarily making efficient IP strategies, it could be meaningless for having intervention by the government, which also has costs from the public interest.

Therefore, since patent subsidy is endogenous for the SMEs, in order to improve SMEs' patenting propensity and patent commercialization, the government should provide more supports to SMEs, in the forms of education and substantial facilitation of their patent management, other than the mere patent subsidy with an underlying discrimination of patent quality by the government itself.

VI. Conclusion

Patents can be a significant measure of promoting innovation by SMEs, but it does not mean that patents are the optimal measure to compensate their R&D and continuously supply innovation incentives to them. Nevertheless, patents are popular as an economy strategy undertaken by the Chinese government for the last ten years. No matter what IPRs mean to the SME applicants, my empirical results imply that under the Chinese government's instruction through grants or subsidies, China has already had an environment where R&D investment of SMEs is positively associated with their patent applications, in the categories of both utility patent and utility model.

Unfortunately, my empirical results also suggest that most SMEs fail to undertake appropriate IP strategies. On the one hand, they cannot efficiently deploy their patents to generate revenue from the market. On the other hand, they cannot wisely employ the patent policies to acquire as much protection as they can under the patent law with the same degree of R&D spending. Therefore, the government should understand the difference of the demands of SMEs and large firms for IP protection to adjust its pro-patent policies. Otherwise, the proliferation of patent application filings by SMEs could create unpredictable transaction costs to impede their growth, innovation and even others players' innovation in the market.

Alternatively, when directly funding or subsidizing SMEs' R&D and patenting activities, the government can contemplate to further educate them on IP strategies. Cash contributions from the government, either *ex ante* or *ex post* for the patent applications, are significant but also limited to promote SMEs' innovation. It will be useful to strengthen the *ex ante* non-cash contributions, like IP-content education by the government or the market involving the third parties that provide services regarding IP strategies. The effects of the third parties on facilitating SMEs' IP commercialization worths to be further explored.

It is possible that not enough evidence is collected in the short five-year duration showing that the SMEs could make successfully IP commercialization. Therefore, it is meaningful to

track the R&D spending and patenting activities of the SMEs in the following years.

VII. Tables and Figures

Table 3.1. Models to Predict Patenting Propensity

Panels	Beijing			Shanghai			Overall		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Predictors	Utility	UM	Design	Utility	UM	Design	Utility	UM	Design
	RE	RE	RE	FE	RE	FE	RE	RE	FE
R&D Intensity (R&D/Employee)	0.579*	-0.167*	-0.0571	0.0622	-0.587***	0.268	0.426**	-0.246***	-0.0251
	(0.303)	(0.0964)	(0.0403)	(0.224)	(0.185)	(0.256)	(0.205)	(0.0849)	(0.0839)
R&D	0.000787***	-8.38e-05	-1.59e-05	-1.54e-05	0.000409**	-0.000272	0.000532***	2.69e-05	2.41e-05
	(0.000290)	(9.10e-05)	(3.78e-05)	(0.000206)	(0.000178)	(0.000235)	(0.000200)	(8.30e-05)	(8.34e-05)
#Utility Patent Application Filings		0.332***	0.135***		0.599***	-0.0894		0.345***	0.109***
		(0.0169)	(0.00716)		(0.0621)	(0.0809)		(0.0165)	(0.0151)
#Court	-0.0220	0.157	-0.0447	0.111	0.125	-0.123	0.0934	0.144	-0.0883
	(0.395)	(0.131)	(0.0564)	(0.154)	(0.148)	(0.177)	(0.241)	(0.0991)	(0.0818)
Appeal Rate	-41.90	-20.28*	-6.435	-14.05	-9.964	15.26	-33.26*	-17.13**	2.711
	(32.38)	(10.78)	(4.638)	(13.16)	(12.62)	(15.09)	(20.09)	(8.267)	(6.850)
#Total Utility Patent Application Filings	-1.29e-05	-2.39e-05	4.35e-06	-1.97e-05	-1.79e-05	1.36e-05	-2.42e-05	-2.17e-05	1.02e-05
	(5.71e-05)	(1.90e-05)	(8.17e-06)	(2.24e-05)	(2.15e-05)	(2.56e-05)	(3.50e-05)	(1.44e-05)	(1.19e-05)
Constant	10.40	1.084	4.325	-2.545	-2.106	-1.972	1.988	1.157	2.915
	(19.60)	(6.408)	(2.740)	(7.472)	(8.395)	(8.548)	(12.31)	(5.068)	(3.918)
Observations	379	379	379	264	264	264	643	643	643
Number of stock	80	80	80	56	56	56	136	136	136
Tech Fe	Yes	Yes	No	No	Yes	No	Yes	Yes	No
Size	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Grant Fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tax Credit Fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.0907	0.5032	0.4609	0.078	0.3221	0.089	0.0617	0.4184	0.128
Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.									

Table 3.2. Models to Predict Utility Patenting Propensity

Panels	Beijing	Shanghai	Overall
Predictors	(1)	(2)	(3)
	RE	RE	RE
R&D Intensity (R&D/Employee)	0.616 (0.464)	0.0576 (0.297)	0.545* (0.307)
R&D	0.00106*** (0.000406)	0.00104** (0.000489)	0.00103*** (0.000298)
#Court	-0.572 (0.664)	0.135 (0.275)	-0.298 (0.432)
Appeal Rate	-31.91 (65.24)	-24.32 (22.84)	-33.29 (39.44)
#Total Utility Patent Application Filings	5.98e-05 (9.71e-05)	-1.94e-05 (4.02e-05)	2.76e-05 (6.30e-05)
Constant	43.54 (36.19)	5.815 (14.89)	24.15 (21.51)
Observations	218	140	358
Number of stock	62	42	104
Tech Fe	Yes	Yes	Yes
Size	Yes	Yes	Yes
Grant Fe	Yes	Yes	Yes
Tax Credit Fe	Yes	Yes	Yes
R-square	0.1320	0.1751	0.1320
Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.			

Table 3.3. Models to Estimate the Efficiency of Business Running

Panels	Beijing			Shanghai			Overall		
Models	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Predictors	Revenue	Asset Turnover	Net Profit	Revenue	Asset Turnover	Net Profit	Revenue	Asset Turnover	Net Profit
	RE	RE	FE	RE	RE	RE	RE	FE	RE
R&D Intensity (R&D/Employee)	1,072*** (383.9)	-0.000359 (0.00723)	259.2* (150.2)	453.4 (443.7)	-0.00340 (0.00645)	-26.91 (105.6)	834.2*** (290.6)	0.00303 (0.00567)	145.5 (98.86)
#Issued Utility	-426.5* (254.3)	-0.0221*** (0.00503)	356.8** (170.5)	2,467** (1,099)	0.00152 (0.0170)	543.0** (263.9)	-284.8 (233.7)	-0.0279*** (0.00439)	404.6*** (130.5)
#Issued Utility Models	562.1** (236.2)	0.00152 (0.00470)	-139.9 (94.54)	-272.7 (214.8)	-0.00124 (0.00313)	72.72 (75.79)	192.7 (146.8)	-0.00176 (0.00280)	-104.0** (52.93)
#Issued Design Patents	-849.7 (522.4)	-0.00869 (0.0104)	-540.5*** (200.7)	-28.25 (183.7)	0.00227 (0.00273)	142.7 (105.1)	-101.0 (179.2)	-0.00151 (0.00339)	-198.1* (106.8)
#Software Copyrights	74.27 (236.8)	-0.00620 (0.00439)	-21.47 (104.9)	114.0 (267.9)	-0.000290 (0.00329)	52.30 (79.71)	101.1 (178.5)	-0.00533 (0.00377)	72.94 (67.69)
#Issued Utility Patents_1			409.9 (249.5)			109.0 (324.8)			-451.4** (196.9)
#Issued Utility Patents_2			-181.2 (447.9)			368.1 (679.7)			136.2 (358.8)
#Issued Utility Models_1			314.4*** (106.9)			51.99 (103.7)			267.0*** (65.61)
#Issued Utility Models_2			-69.23 (146.9)			-207.5* (124.5)			-93.67 (83.98)
#Issued Design Patents_1			-167.6 (228.2)			-229.8*** (46.80)			-231.5*** (60.06)
#Issued Design Patents_2			-451.9 (345.3)			-134.7*** (51.19)			-181.9*** (64.53)
#Software Copyrights_1			58.49 (93.54)			62.22 (107.2)			65.89 (74.32)
#Software Copyrights_2			-220.0** (110.2)			-43.75 (118.5)			-184.3** (83.20)
Appeal Rate	-131,944*** (25,681)	3.098*** (0.511)	-23,454 (21,258)	-103,138*** (27,236)	2.462*** (0.406)	-26,757 (18,429)	-116,005*** (18,854)	2.738*** (0.360)	-18,312 (14,874)
1. Dummy Issued Patents	5,421* (3,173)	0.0595 (0.0636)	-2,002* (1,183)	2,083 (4,167)	-0.0716 (0.0643)	-288.6 (1,044)	6,470*** (2,359)	0.0417 (0.0437)	-1,459* (801.8)
Constant	11,623 (15,429)	0.209 (0.177)	5,047 (4,334)	49,689* (29,822)	0.394 (0.283)	15,050* (8,487)	21,245 (14,873)	0.237* (0.137)	8,656* (5,115)
Observations	379	379	223	264	264	152	643	643	375
Number of stock	80	80	77	56	56	53	136	136	130
Tech Fe	Yes	No	No	Yes	Yes	Yes	Yes	No	Yes
Size	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Grant Fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tax Credit Fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.5117	0.2555	0.3287	0.4634	0.2476	0.3806	0.4744	0.245	0.2621

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 3.4. Product-Term Models to Predict Asset Turnover Ratio

Panels	Beijing	Shanghai	Overall
Predictors	(1)	(2)	(3)
	RE	RE	FE
#Issued Utility Patents	0.0222 (0.0228)	0.132** (0.0547)	0.0257 (0.0183)
#Issued Utility Model	0.00413 (0.00486)	-0.00265 (0.00313)	-0.000240 (0.00282)
#Software Copyright	-0.00591 (0.00437)	-0.00138 (0.00320)	-0.00512 (0.00374)
#Issued Design Patents	-0.0106 (0.0104)	0.00247 (0.00270)	-0.00138 (0.00336)
R&D Intensity (R&D/Employee)	0.000919 (0.00723)	-0.00322 (0.00637)	0.00422 (0.00564)
Appeal Rate	3.213*** (0.512)	2.557*** (0.405)	2.829*** (0.359)
#Issued Utility Patents×Appeal Rate	-0.494** (0.248)	-1.400** (0.558)	-0.598*** (0.198)
1.Dummy Issued Patents	0.0809 (0.0642)	-0.0229 (0.0667)	0.0666 (0.0441)
Constant	0.187 (0.176)	0.369 (0.271)	0.222 (0.136)
Observations	379	264	643
Number of stock	80	56	136
Tech Fe	No	Yes	No
Size	Yes	Yes	Yes
Grant Fe	Yes	Yes	Yes
Tax Credit Fe	Yes	Yes	Yes
R-square	0.2711	0.2637	0.258
Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.			

Table 3.5. Diff-in-Diff-in-Diff Model to Estimate the Efficiency of R&D Commercialization

Predictors	Revenue	Revenue	Revenue
	(1)	(2)	(3)
SH compared to BJ before 2012	3,866 (3,266)	3,441 (3,273)	3,555 (3,286)
BJ after 2012 compared to before 2012	16,793*** (3,318)	17,386*** (3,334)	16,586*** (3,359)
#Issued Utility Patents	3,335* (1,819)	2,101 (1,975)	1,454 (2,017)
SH compared to BJ before 2012×	3,034* (1,655)		
BJ after 2012 compared to before 2012	-3,252* (1,850)		
BJ×Before 2012×#Issued Utility		0 (0)	0 (0)
BJ×After 2012×#Issued Utility		-1,991 (2,010)	-1,437 (2,040)
SH#Before 2012×#Issued Utility		9,781** (4,546)	9,944** (4,542)
SH×After 2012×#Issued Utility		175.9 (2,657)	305.9 (2,658)
#Issued Utility Models			365.2 (227.6)
#Software Copyrights			180.5 (197.7)
Constant	41,252*** (2,388)	41,234*** (2,386)	40,262*** (2,484)
Observations	648	648	648
R-squared	0.063	0.067	0.072
Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.			

Table 3.6. The Effect of Issued Utility Patents on Revenue Before and After 2012's the Shanghai Patent Subsidy Policy Change

Time horizon	Shanghai SMEs' Issued Utility Patents	Beijing SMEs' Issued Utility Patents	Difference of the Effect of Issued Utility Patents on Revenue
before 2012 (Control)	11398.55*** (4120.608)	1,454 (2,017)	9,944** (4,542)
after 2012 (Treated)	1.76E+03 (1741.536)	1.70E+01 (405.5216)	1.74E+03 (1755.908)
after2011-before2011	-9638.286** (4,389.619)	-1,437 (2,040)	-8,201* (4,787)

Note: the estimation counts the covariates of the number of issued utility models and registered copyrights, time horizon Fe, and area Fe. Standard errors in parentheses, *** p<0.01, ** p<0.05, *

Table 3.7. The Effect of Patent Subsidy on Patenting Propensity Before and After IPO

Dependent Variables Patenting Propensity	Independent Variables					Tech Fe	R-sq	Obs.	Model Types
	patent subsidy	utility patent	R&D Intensity	R&D Investment	Revenue				
1. Utility Patents									
After IPO (A)	0.127** (0.0536)		0.168 (0.242)	0.000485** (0.000241)	0.000100*** (2.63e-05)	No	0.100	642	FE
Before IPO (B)	-0.0761 (0.108)		-0.0164 (0.213)	0.00262*** (0.000476)	-6.06e-05* (3.43e-05)	Yes	0.1145	193	RE
P-value of Difference (A)-(B)	[0.856]		[0.190]	[0.034]	[0.062]				OLS
2. Utility Models									
After IPO (A)	0.0165 (0.0220)	0.315*** (0.0183)	-0.215** (0.0989)	4.92e-05 (9.87e-05)	4.53e-05*** (1.09e-05)	No	0.442	642	FE
Before IPO (B)	-0.0393 (0.0743)	0.302*** (0.0669)	-0.0352 (0.200)	0.00161* (0.000808)	-8.92e-05 (6.06e-05)	No	0.391	193	FE
P-value of Difference (A)-(B)	[0.812]	[0.367]	[0.923]	[0.622]	[0.975]				OLS
3. Designs									
After IPO (A)	0.0590*** (0.0174)	0.111*** (0.0141)	-0.0533 (0.0716)	-1.54e-05 (7.12e-05)	2.07e-06 (7.15e-06)	Yes	0.1281	642	RE
Before IPO (B)	-0.00856 (0.0472)	0.145*** (0.0269)	-0.138** (0.0686)	-0.000253 (0.000167)	-4.60e-06 (1.08e-05)	Yes	0.0450	193	RE
P-value of Difference (A)-(B)	[0.541]	[0.471]	[0.673]	[0.505]	[0.919]				

Note: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The models also controls for court, appealrate=patent application rejection appeals/total patent applications, total utility patent filings, year fixed and firm size. The model type is selected by Hausman test.

Figure 3.2.

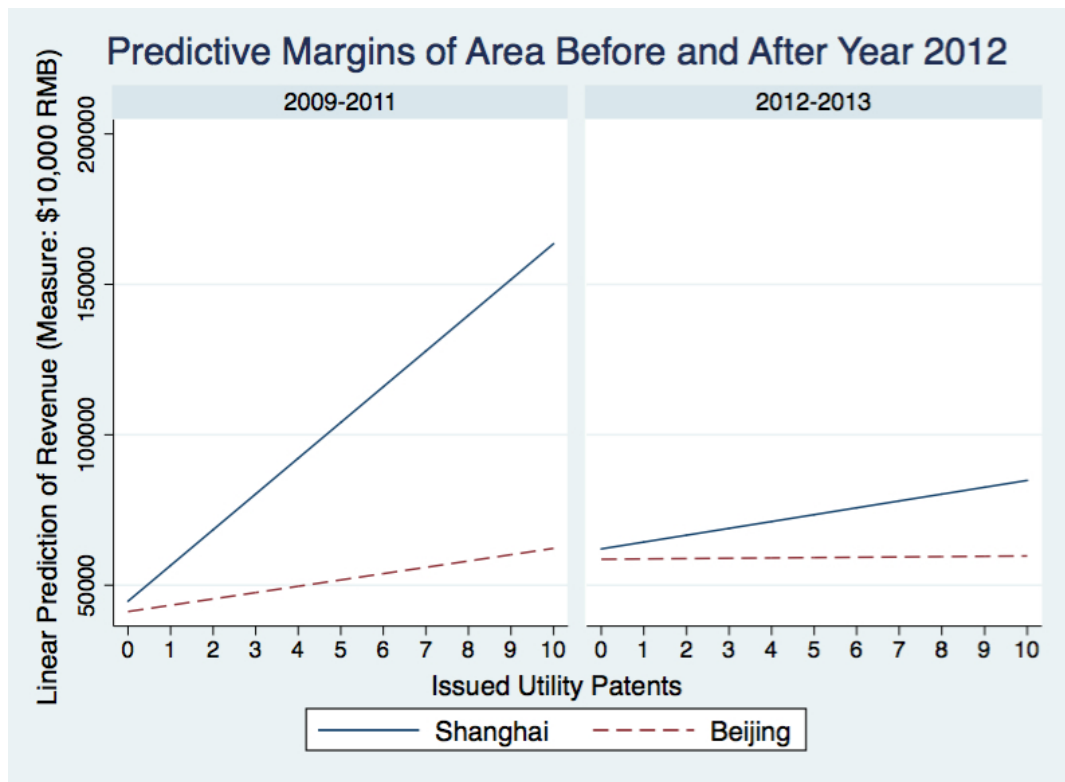
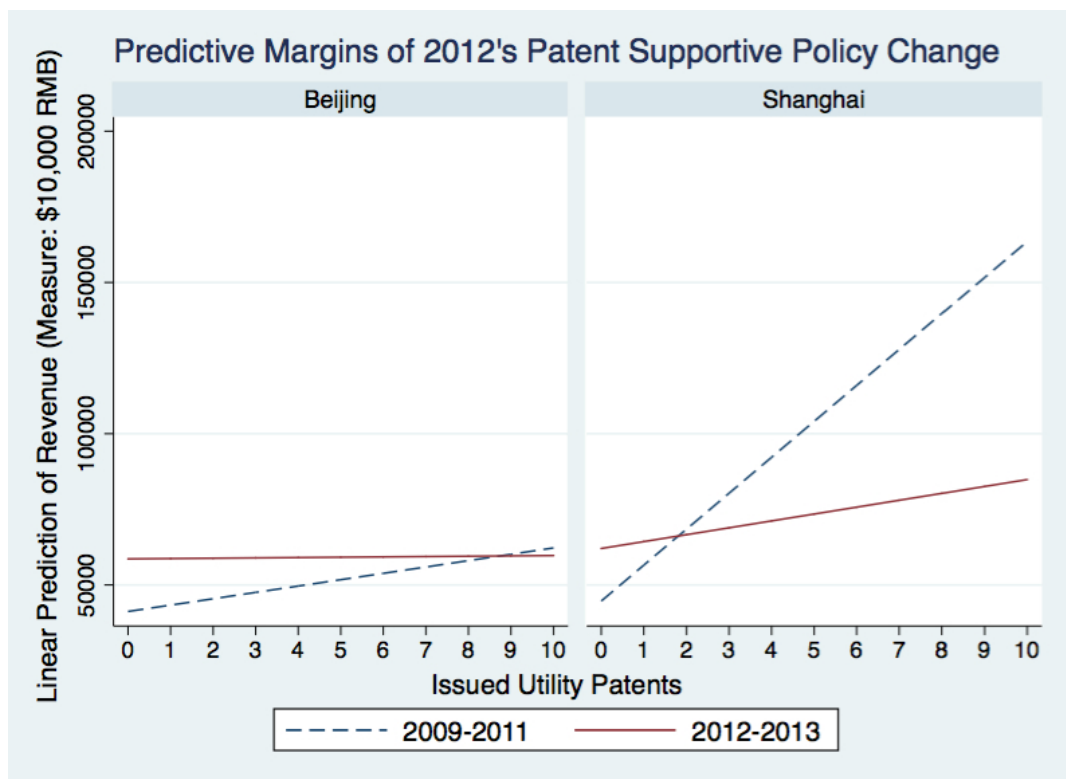


Figure 3.3.



CHAPTER FOUR EXTERNAL FINANCING & SMES' TECHNICAL INNOVATION

I. Literature Review

Either equity financing or debt financing could become a crucial source of capital to support R&D by SMEs. Meanwhile, innovations, in the form of R&D expenditure or IPs, are critical characteristics that equity or debt investors consider when they decided to invest in SMEs. This part discusses how the literature explains the connection between innovation and the financial market. Section 1 introduces the importance of equity financing and debt financing to the portfolio SMEs and their innovation, and the innovative SMEs' financing difficulties with those two capital resources. Section 2 explains the interplay of the various types of investors on IP activities by the portfolio SMEs.

Since Chapter 2 has introduced the monetary subsidies by governments, in Section 3, the literature discusses the existing and suggested policies and regulations to structure a reasonable financial market so as to indirectly support innovative SMEs.

1. Equity Financing and Debt Financing

Besides the compensation of technology development through the market by IP, discussed by the literature review in Chapter 1, Section 1 presents the literature about another capital resource for firms, that is, investment. The literature in Section 1.1 discusses how private equity investment through venture capital or private equity funds effect on the innovation by SMEs in developing countries. To understand the incentives of these private investors better, Section 1.2 presents the literature that discusses IPO, an important way of exit of their investment. Meanwhile, the literature in this part will also show how IPO and public equity market are important to the portfolio firms and their innovation activities.

Then, I categorize the resources of investments by countries to introduce international

financial flows in Section 1.3. In this part, the literature specifically discusses a crucial type of international investment, foreign direct investment (FDI), and how FDI and these foreign VC investors affect the R&D of firms in the domestic market.

Section 1.4 presents the literature about debt financing. Comparing with equity investment discussed earlier in this part, I try to explore whether or not debt financing is an efficient financing measure to firms, especially to innovative SMEs, through the literature in this part. The literature also argues on how the efficiency of debt financing would be in various economic environments and legal environments.

1.1. Venture Capital or Private Equity

Much literature theoretically shows how venture capital or private equity is important to stimulate R&D in various countries and industries, or shows empirical methods to support that. I thus present this literature first in Section 1.1.1 to provide the basic rationales for why I have this part when I consider stimulating R&D by SMEs. Then, Section 1.1.2 presents the literature that discusses the important meaning of VC/PE to SMEs and the difficulties for SMEs to acquire them. Because the difficulties could be bigger in immature VC/PE markets, the literature in Section 1.1.3 introduces successful and failed experiences in select countries and discusses the key obstacles of structuring a proper and successful VC/PE market in developing countries.

1.1.1. VC/PE and Innovation

After the success of Silicon Valley and Route 128 regions, generally, almost all scholars agree that venture capital is an important engine of innovation by high-tech firms.³⁶⁴ Barkoczy and Edmundson define venture capital as the investment “specifically targeted at companies with

³⁶⁴ Gompers and Lerner, *The Venture Capital Cycle*, 273.

the potential for rapid growth.”³⁶⁵ Jeng and Wells believe that venture capital stimulates innovation to commercialize at a rapid speed so as to create growth of economy, employment and further technical innovations.³⁶⁶

Moreover, Gilson concludes that the venture capital market significantly connects finance and innovation.³⁶⁷ Also, Gulinello recognizes that venture capital market contributes to the growth and development of high-technology industries, particularly for high-risk, high potential return business.³⁶⁸ Barkoczy and Edmundson explain that innovative business requires significant investment from venture capital to develop and commercialize new products and technologies.³⁶⁹

In an empirical study with German SMEs, Mueller and Reize note that venture capital is suitable only for few SMEs in Germany, and the high R&D intensity or continuous R&D activity happening in these SMEs require high share of investment from venture capital.³⁷⁰ Gompers and Lerner conducted an empirical study to learn the U.S. manufacturing industry, and its result suggests that venture capital stimulates R&D and patent production.³⁷¹ In the U.S., venture capital shared eight percent of industrial innovations from 1983 to 1992, and accounted for nine percent of industrial innovations in 1992³⁷² and fourteen percent of the U.S. innovative activity by 1998.³⁷³ In Canada in 1996, 62 percent of the 525 companies financed by venture capital were technology-based business.³⁷⁴

The Chinese scholars in Chinese Academy of Science and Technology for Development

³⁶⁵ Barkoczy and Edmundson, “Australasian and South East Asian Venture Capital Tax Expenditure Programs,” 58.

³⁶⁶ Jeng and Wells, “The Determinants of Venture Capital Funding: Evidence across Countries,” 242.

³⁶⁷ Gilson, “Engineering a Venture Capital Market: Lessons from the American Experience,” 55.

³⁶⁸ Gulinello, “Engineering a Venture Capital Market and the Effects of Government Control on Private Ordering: Lessons from the Taiwan Experience,” 845.

³⁶⁹ Barkoczy and Edmundson, “Australasian and South East Asian Venture Capital Tax Expenditure Programs,” 58.

³⁷⁰ Mueller and Reize, *Loan Availability and Investment: Can Innovative Companies Better Cope with Loan Denials?* 21.

³⁷¹ Gompers and Lerner, *The Venture Capital Cycle*, 290, 293.

³⁷² Ibid. 294.

³⁷³ Samuel Kortum and Josh Lerner, “Assessing the Contribution of Venture Capital to Innovation,” *RAND Journal of Economics* 31 (2000): 697.

³⁷⁴ Rousseau, “The Future of Capital Formation for Small and Medium-Sized Enterprises: Rethinking Initial Public Offering Regulation after the Restructuring of Canadian,” 698.

(CASTED) announce that the venture capital market in China was born to the goal of encouraging the development of technology.³⁷⁵ Actually, many other countries, such as Israel, Singapore, and the member nations of the E.U., agree that venture capital can spur innovation, especially high-tech R&D activities.³⁷⁶

After learning the reasons of the substantial reduction in investment and R&D in many U.S. manufacturing firms during the 1980s, Hall reminds us that investment and R&D investment are distinguished to the considerations of investors.³⁷⁷ Arrow explains that the risk of moral hazard is the biggest obstruction of acquiring external financing in R&D intense firms, which has been agreed by many other scholars.³⁷⁸ However, for high-tech SMEs, either type of venture capital investment is an essential approach to assist them, because it is difficult for them to enter high-risk nature of high-technology industries and survive there.³⁷⁹ Also, the operation and business of portfolio companies are connected with venture capital.³⁸⁰ In order to understand this connection in a map broader than the innovation activities of the SMEs, we should learn how venture capital funds impact on the interior of SMEs.

1.1.2. VC/PE and SMEs

Because the establishment or development of innovative SMEs is highly risky, Ptacek believes that it deters private financing and formalizes a large “equity gap” between angel investors and venture capital funds in European countries.³⁸¹ Actually, besides the issue of the

³⁷⁵ Zhang Lin, “Legal Ecology of China’s Venture Capital Market: Reflection in the American Mirror,” *Kor. U. L. Rev.* 13 (2013): 79.

³⁷⁶ Gompers and Lerner, *The Venture Capital Cycle*, 274.

³⁷⁷ Hall, *Investment and Research and Development at the Firm Level: Does the Source of Financing Matter*, 1, 5.

³⁷⁸ Arrow, “Economic Welfare and the Allocation of Resources for Invention,” 612. Also see, Himmelberg and Petersen, “R&D and Internal Finance: A Panel Study of Small Firms in High-Tech Industries,” 38.

³⁷⁹ Gulino, “Engineering a Venture Capital Market and the Effects of Government Control on Private Ordering: Lessons from the Taiwan Experience,” 857-858.

³⁸⁰ Rajarishi Nahata, “Venture Capital Reputation and Investment Performance,” *Journal of Financial Economics* 90, no. 2 (November 2008): 133-134, accessed June 21, 2016, <http://linkinghub.elsevier.com/retrieve/pii/S0304405X08001414>.

³⁸¹ Ondrej Ptacek, “Delivering Support to SMEs in a Business-Friendly Way: The Seed Fund,” *Eur. Procurement & Pub.*

limited scope and amount of support by angel investors, the high-risk situation always creates a considerable gap between sources of capital and the demands of SMEs,³⁸² especially for the small firms at the inception stage.³⁸³ Hence, Barkoczy and Edmundson believe that venture capital funds are important to the development of SMEs.³⁸⁴

Comparing to debt financing with a lower cost than equity financing³⁸⁵, Barkoczy and Edmundson conclude that venture capital finance is much more appropriate and manageable for SMEs because of the restricting barriers of the obligation of regular interest repayments.³⁸⁶ Jeng and Wells agree that this will conflict with the demands of high cash flow of SMEs on R&D and other activities, and they emphasize that most of SMEs are even unlikely to obtain loans successfully because of their lack of tangible assets as collateral.³⁸⁷ Hence, regarding this situation, as Rousseau concludes, equity capital is more feasible to SMEs, especially in the knowledge-based industries.³⁸⁸

When discussing the possibility of other types of equity financing, Jeng and Wells believe that the resources from angel investors and large corporations are limited in amounts and in the possibility of success.³⁸⁹ Moreover, the regulations of financial institutions in the U.S. outlined by Roe suggest that banks, insurance companies and mutual funds in the U.S. are restricted from holding large equities of one company and being active on their business as directors of boards.³⁹⁰ The empirical study conducted by Puri and Zarutskie also confirms that the U.S.

Private Partnership L. 2012 (2012): 278.

³⁸² Barkoczy and Edmundson, "Australasian and South East Asian Venture Capital Tax Expenditure Programs," 56.

³⁸³ Pizzacalla, "SME 'Life Cycle' Imperative," 191.

³⁸⁴ Barkoczy and Edmundson, "Australasian and South East Asian Venture Capital Tax Expenditure Programs," 56.

³⁸⁵ Jack S. Levin and Donald E. Roca, *Structuring Venture Capital, Private Equity, and Entrepreneurial Transactions* (Wolters Kluwer Law & Business, 2012), 1-7.

³⁸⁶ Barkoczy and Edmundson, "Australasian and South East Asian Venture Capital Tax Expenditure Programs," 59.

³⁸⁷ Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries," 245-256. Also see, Sibbitt, "Law, Venture Capital, and Entrepreneurism in Japan: A Microeconomic Perspective on the Impact of Law on the Generation and Financing of Venture Businesses," 95.

³⁸⁸ Rousseau, "The Future of Capital Formation for Small and Medium-Sized Enterprises: Rethinking Initial Public Offering Regulation after the Restructuring of Canadian," 666.

³⁸⁹ Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries," 246.

³⁹⁰ Mark J Roe, "Political and Legal Restraints on Ownership and Control of Public Companies," *Journal of Financial Economics* 27 (1990): 7.

companies particularly demand venture capital funds for the scale of investment and production.³⁹¹

Actually, other than proving financial support to portfolio companies through contracts, venture capital investors can also play a value-adding role on the business of SMEs through non-contractible inputs.³⁹² Hence, many scholars remind that venture capital funds also provide non-financial support, such as management assistance, and access to better suppliers, lenders, employees and investment bankers.³⁹³ Gilson agrees that when venture capital funds intensively monitor the performance of the portfolio companies in an objective view, they make and are expected to make non-cash contributions, including the use of the reputation of the fund to attract potential customers, going beyond the duties by the formal legal documents between the funds and the portfolio companies.³⁹⁴ Comparatively, pension funds, insurance companies and money managers actively invest in the business of portfolio companies due to their legal structures and customs.³⁹⁵

Beyond the above theoretical evidence, Nahata conducted an empirical study with the public U.S. companies having initial VC funding between 1991 and 2001, and its results show that venture capital funds make the most contributions to these companies than any other types of financing.³⁹⁶

While many scholars agree the important role that venture capital plays in the survival and growth of SMEs, they argue about the measures to induce venture capital investors to SMEs properly. For SMEs, acquiring equity financing is a huge business decision to make carefully

³⁹¹ Manju Puri and Rebecca Zarutskie, *On the Lifecycle Dynamics of Venture-Capital and Non-Venture-Capital Financed Firms*, NBER, 2008, 29.

³⁹² Laura Bottazzi, Marco Da Rin, and Thomas Hellmann, "What Is the Role of Legal Systems in Financial Intermediation? Theory and Evidence," *Journal of Financial Intermediation* 18, no. 4 (October 2009): 560, accessed June 21, 2016, <http://linkinghub.elsevier.com/retrieve/pii/S104295730800034X>.

³⁹³ Ibid. 560. Also see, Gulinello, "Engineering a Venture Capital Market and the Effects of Government Control on Private Ordering: Lessons from the Taiwan Experience," 846. Also see, Nahata, "Venture Capital Reputation and Investment Performance," 133. Also see, Barkoczy and Edmundson, "Australasian and South East Asian Venture Capital Tax Expenditure Programs," 59.

³⁹⁴ Gilson, "Engineering a Venture Capital Market: Lessons from the American Experience," 61.

³⁹⁵ Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries," 246.

³⁹⁶ Nahata, "Venture Capital Reputation and Investment Performance," 141, 144, 148.

because they must pay a large premium to the investors based on the success of their high-risk programs.³⁹⁷ Also, while venture capital funds are understood as financial intermediaries to fill the gap between investors and high-tech SMEs,³⁹⁸ because of the unbalanced development of venture capital market around the world, the venture capital markets in many countries other than the U.S. are immature so as to be still inefficient.³⁹⁹

1.1.3. Developing a VC/PE market in developing countries

Gilson believes that the U.S. venture capital structures investment to make early stage financing feasible.⁴⁰⁰ Because the countries other than the U.S. have relatively less experienced VC investing, Kaplan and Stromberg suggest that the U.S. style contracts are optimal structures in a VC market.⁴⁰¹ However, they and Martel also realize that not all countries adopt the U.S. style of contracts.⁴⁰² Similarly, Bottazzi, Da Rin and Hellmann claim that the U.S. is the market leader in venture capital, but they also emphasize the importance of understanding cross-country differences in financial intermediary.⁴⁰³

Looking into the VC markets in various countries, Jeng and Wells conclude that Japanese and German venture capital funds are not actively involved in monitoring their investments as those in the U.S.⁴⁰⁴ The U.S. used to have the greatest amount of private equity, but the amount

³⁹⁷ Sibbitt, "Law, Venture Capital, and Entrepreneurism in Japan: A Microeconomic Perspective on the Impact of Law on the Generation and Financing of Venture Businesses," 64.

³⁹⁸ Gulinello, "Engineering a Venture Capital Market and the Effects of Government Control on Private Ordering: Lessons from the Taiwan Experience," 858.

³⁹⁹ Barkoczy and Edmundson, "Australasian and South East Asian Venture Capital Tax Expenditure Programs," 56.

⁴⁰⁰ Gilson, "Engineering a Venture Capital Market: Lessons from the American Experience," 57.

⁴⁰¹ Steven N Kaplan and PER Stromberg, "Financial Meets Theory Contracting An Empirical the Real World : Of Venture Analysis Capital Contracts," *Review of Economic Studies* 70 (2003): 313.

⁴⁰² Steven N. Kaplan, Frederic Martel, and Per Strömberg, "How Do Legal Differences and Experience Affect Financial Contracts?," *Journal of Financial Intermediation* 16, no. 3 (July 2007): 306.

⁴⁰³ Bottazzi, Da Rin, and Hellmann, "What Is the Role of Legal Systems in Financial Intermediation? Theory and Evidence." 561.

⁴⁰⁴ Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries," 248.

of fund flowing into private equity in U.K. was slightly exceeding it.⁴⁰⁵ Therefore, in order to understand which road is the most appropriate one for developing countries, in addition to understanding their failures, it is also necessary to review and understand the arguments among the scholars on different styles of management in different economies and the structures of venture capital environments in these economies.

The discrimination of analyzing venture capital market is reasonable under the statistics of eighty countries over 1960-1989 by Levine who observed that the financial environment including bank, non-bank, private share and stock market but not limited in VC environment are developing as the economies grow.⁴⁰⁶ When only focusing on VC or PE markets, Lerner, Hardyman and Leamon conclude that the implementation of PE in developing countries is obviously distinguished from that in developed countries, while fund structures like limited partnership and capital sources in these countries are similar under globalization.⁴⁰⁷ Concretely, the different investment processes in developing and developed countries include the types of deals, the process of identifying and evaluating, the investment structures and valuation.⁴⁰⁸

About deal structure, investors in developed countries use common stock, preferred stock, debt and convertible preferred stock.⁴⁰⁹ As Kaplan and Stromberg describe, over 95 percent of private equity investment in the U.S. are dominated by convertible preferred stock.⁴¹⁰ Under a statistic by Lerner and Schoar, not more than 10 percent of private equity deals in the U.S. use common stock.⁴¹¹ Comparatively, the developing countries in their statistics show 54 percent using common stock in private equity transactions, over double the amount of using convertible

⁴⁰⁵ Ibid. 252.

⁴⁰⁶ Ross Levine, "Financing Functions, Institutions, and Growth," in *Sequencing? Financial Strategies for Developing Countries*, ed. Alison Harwood and Bruce L.R. Smith (Brookings Institution Press, 1997), 20-21.

⁴⁰⁷ Lerner, Hardyman, and Leamon, *Venture Capital and Private Equity: A Case Book*, 243.

⁴⁰⁸ Ibid. 247.

⁴⁰⁹ Ibid. 249-250.

⁴¹⁰ Kaplan, Martel, and Strömberg, "How Do Legal Differences and Experience Affect Financial Contracts?" 281.

⁴¹¹ Josh Lerner and Antoinette Schoar, "Does Legal Enforcement Affect Financial Transactions? The Contractual Channel in Private Equity," *Q. J. ECON.* 120, no. 1 (2005): 231, accessed June 21, 2016, <http://www.jstor.org/stable/25098735>.

preferred stock.⁴¹² Lerner, Hardyman and Leamon explain this phenomena as that many of these countries, especially Asian ones, do not allow different classes of stock with different voting powers,⁴¹³ which results in these developing countries not being able to possess the advantages of a common law system like the U.S. “The rare use of convertible preferred stock prevented active involvement in underperforming assets and often led to weaker liquidation and exit rights for foreign venture capitalists.”⁴¹⁴

Truly, besides the economic reasons that only the increase of economy can make more capital available, many scholars, like Gulinello, also recognize other obstacles of the growth of VC market in these countries, such as political reasons and legal forms.⁴¹⁵ Similarly, Ptacek taking the example from Czech Republic explains that the amount of venture capital investment does not depend on the level of economy of a country but rather depends on its local laws.⁴¹⁶ Czech Republic used to merely have concentrated investment on buyout, replacement and growth segment, but its venture capital market expanded after the law of collective investment was amended.⁴¹⁷ Jackson explains that the different financial regulations among different countries could arise out of the differences on their political goals or the identical levels of regulatory intensity.⁴¹⁸

When comparing the return of PE funds in common law developing countries and civil law developing countries, Lerner and Schoar find empirical evidence to show that the former one was on average 19 percent higher than the return in socialist and civil law countries in 2004, and they believe the reason is that common law countries have better legal enforcement, especially on contracts, so the investors there prefer using convertible preferred stock to using common

⁴¹² Ibid. 230.

⁴¹³ Lerner, Hardyman, and Leamon, *Venture Capital and Private Equity: A Case Book*, 250.

⁴¹⁴ Ibid. 250.

⁴¹⁵ Gulinello, “Engineering a Venture Capital Market and the Effects of Government Control on Private Ordering: Lessons from the Taiwan Experience,” 858, 846.

⁴¹⁶ Ptacek, “Delivering Support to SMEs in a Business-Friendly Way: The Seed Fund,” 279.

⁴¹⁷ Ibid. 279.

⁴¹⁸ Howell E Jackson, “Regulatory Intensity in the Regulation of Capital Markets: A Preliminary Comparison of Canadian and U.S. Approaches,” 2006, 84, accessed June 21, 2016, [http://www.tfmsl.ca/docs/V6\(2\) Jackson.pdf](http://www.tfmsl.ca/docs/V6(2) Jackson.pdf).

stock or straight debt.⁴¹⁹ The empirical evidence shows that equity investment transactions in common law countries are more likely to include contractual protection.⁴²⁰ In contrast, Lerner and Schoar suggest that the limitation of civil law system is its weak enforcement of contracts dividing cash flow and control rights.⁴²¹ Thus, the investors pursuing flexible capital management hardly rely on the portfolio companies and they could only choose debt investment instead of equity investment.⁴²² The empirical study conducted by Bottazzi, Da Rin and Hellmann, who defining common law system as a better legal system than civil law system, find that investors provide more non-contractible support in common law countries because common law countries provide better downside protection for them.⁴²³

While Kaplan, Martel and Stromberg agree that the U.S. has the best legal regime to enforce contracts when VC funds in other areas are less likely to use contingency or convertible preferred stock, they find that the reason why the experienced VC funds in the U.S. are more likely to use tough contracts could be not about efficiency but about practice.⁴²⁴ In their empirical study across 23 countries, they prove the efficiency of the U.S. style contracts under both common law regime and civil law regime.⁴²⁵ Without a testified causality, they still firmly believe that it is the U.S. style contracts rather than the common law regime that result in the success of VC funds because the investments in these countries could be more similar to the U.S. style contracts.⁴²⁶ This result could prove the efficiency of the U.S. style contracts.⁴²⁷ Meanwhile, because the experienced venture capital funds use the U.S. style contracts under any legal regime and VCs from trusting culture do not need them, Kaplan, Martel and Stromberg do

⁴¹⁹ Lerner and Schoar, "Does Legal Enforcement Affect Financial Transactions? The Contractual Channel in Private Equity." 224. 241.

⁴²⁰ Ibid. 238.

⁴²¹ Ibid. 224.

⁴²² Ibid. 224-225.

⁴²³ Bottazzi, Da Rin, and Hellmann, "What Is the Role of Legal Systems in Financial Intermediation? Theory and Evidence." 560.

⁴²⁴ Kaplan, Martel, and Strömberg, "How Do Legal Differences and Experience Affect Financial Contracts?" 274-275.

⁴²⁵ Ibid. 275.

⁴²⁶ Ibid. 275.

⁴²⁷ Ibid. 306.

not think that enforcement of law in civil law countries is a major problem.⁴²⁸

The extremely effective contracting structure⁴²⁹ is not limited to the connection between venture capital funds and portfolio companies, but also includes the connection between investors and venture capitalists. In this side, Gomper finds that restrictive covenants are too costly to be used in a high frequency, especially when the market has high demand of venture funding.⁴³⁰ On the one hand, Jeng and Wells view the reduction of covenants as an increased compensation for venture capitalists so as to encourage their incentives.⁴³¹ On the other hand, in order to encourage the incentives of investors, Bottazzi, Da Rin and Hellmann suggest that policymakers from the countries other than the U.S. should realize the importance of the U.S. style venture capital model and the contracting system under its common law system.⁴³²

Although Gilson agrees with the success of the U.S. style contracts, he suggests a different path and involving assistance of government in policies and regulations to cure market failure problems to other countries that are emulating the design of VC market developing in the U.S.⁴³³ At this point, Jackson does not recommend these countries to take too many of the U.S. style policies and regulations because they are not optimal for their local VC markets.⁴³⁴

While there is no common consensus among scholars, it is important for developing countries like China to consider its investment environment in the sense of economy, politics and law. Private equity investors concern the highly regulated infrastructure in developing countries, and their stabilization of the regulatory changes and currency.⁴³⁵ Nahata and other scholars have built the empirical evidence that “investment opportunities available to investors affect their

⁴²⁸ Ibid. 309.

⁴²⁹ Gilson, “Engineering a Venture Capital Market: Lessons from the American Experience,” 1102.

⁴³⁰ Paul A. Gompers, “Grandstanding in the Venture Capital Industry,” *Journal of Financial Economics* 42 (1996): 154.

⁴³¹ Jeng and Wells, “The Determinants of Venture Capital Funding: Evidence across Countries,” 254.

⁴³² Bottazzi, Da Rin, and Hellmann, “What Is the Role of Legal Systems in Financial Intermediation? Theory and Evidence,” 591.

⁴³³ Gilson, “Engineering a Venture Capital Market: Lessons from the American Experience,” 1071.

⁴³⁴ Jackson, “Regulatory Intensity in the Regulation of Capital Markets: A Preliminary Comparison of Canadian and U.S. Approaches,” 84.

⁴³⁵ Lerner, Hardyman, and Leamon, *Venture Capital and Private Equity: A Case Book*, 249.

investment decisions and performance.⁴³⁶ Meanwhile, Lerner and Schoar remind that it is important to enforce contracts for the efficiency of court systems, or no matter how the contracts are designed cannot protect investors.⁴³⁷ Besides the enforcement of contracts, the design of contracts would be affected by different legal systems, so Kaplan, Martel and Stromberg suggest designing new protective mechanisms for investors in various legal origins where portfolio companies reside.⁴³⁸

1.2. IPO and Public Equity Market

The Initial public offering (IPO) market is an exit mechanism on VC investments, and its high returns provide the incentives for venture capitalists to invest in SMEs.⁴³⁹ Thus, Black and Gilson state that the potential mechanism for exit through IPO is important for developing an active VC market.⁴⁴⁰ Simultaneously, venture capitalists are important to the efficiency of an IPO market because they monitor portfolio firms and certify the quality of the firms so as to reduce information asymmetries between corporate insiders and prospective investors and help the firms enter public equity market.⁴⁴¹

Gompers et al. present the empirical evidence of that IPOs and investment activities are highly correlated in particular industries, such as Internet and Computers, so they imply that IPOs may make investments in these industries more attractive, which also may attract more

⁴³⁶ Nahata, "Venture Capital Reputation and Investment Performance," 135.

⁴³⁷ Lerner and Schoar, "Does Legal Enforcement Affect Financial Transactions? The Contractual Channel in Private Equity," 226-227.

⁴³⁸ Kaplan, Martel, and Strömberg, "How Do Legal Differences and Experience Affect Financial Contracts?" 284.

⁴³⁹ Rousseau, "The Future of Capital Formation for Small and Medium-Sized Enterprises: Rethinking Initial Public Offering Regulation after the Restructuring of Canadian," 667.

⁴⁴⁰ Bernard S Black and Ronald J Gilson, "Venture Capital and the Structure of Capital Markets: Banks versus Stock Markets," *Journal of Financial Economics* 47 (1998): 243-77, accessed June 21, 2016, <http://www.sciencedirect.com/science/article/pii/S0304405X97000457>. 258.

⁴⁴¹ Rousseau, "The Future of Capital Formation for Small and Medium-Sized Enterprises: Rethinking Initial Public Offering Regulation after the Restructuring of Canadian," 695-699.

entrepreneurs into these industries.⁴⁴² A similar correlation result is also shown in the empirical study conducted by Jeng and Wells. They conclude that IPOs are the strongest driver of VC investing across countries, especially at the later stage of investment.⁴⁴³

Because large profits on IPOs attract venture capitalists, Gulinello suggest structuring a strong and active securities market for realizing private capital in the investments.⁴⁴⁴ Taking the U.S. financial market as an example, Sibbitt claims that its characteristics of the quick returns with the easy liquidity attract both foreign high-tech firms and venture capitalists.⁴⁴⁵ Precisely, Lin reminds that the NASDAQ resulted in the success of American VC market and is still supporting this success by providing an efficient exit channel for VC investors.⁴⁴⁶

While in both the U.S. and the Europe, PE funds can raise more capital based on their healthy IPO markets, Lerner, Hardyman and Leamon doubt if the PE investors can rely on the public markets which cause the difficulty of their exit of the investments.⁴⁴⁷ They see a higher cost of IPO to both the PE investors and portfolio firms than the cost of acquisition.⁴⁴⁸ The high cost of going public to the issuers specifically includes the legal, accounting, underwriter and broker fee, the degree of disclosure in their prospectuses, potential loss of control of the firm permanently, underpriced value of the shares as the concession of the success to IPO, and other potential risks in the management and equity transactions of the firm in the future.⁴⁴⁹

In the case of China, the Chinese Growth Enterprise Market (GEM) can stimulate raising capital into the VC market and be an ideal way to exit for Chinese domestic VC investors, but

⁴⁴² Gompers et al., *Venture Capital Investment Cycle: The Impact of Public Market*, 7-8.

⁴⁴³ Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries," 270, 241.

⁴⁴⁴ Gulinello, "Engineering a Venture Capital Market and the Effects of Government Control on Private Ordering: Lessons from the Taiwan Experience," 876.

⁴⁴⁵ Sibbitt, "Law, Venture Capital, and Entrepreneurism in Japan: A Microeconomic Perspective on the Impact of Law on the Generation and Financing of Venture Businesses," 66.

⁴⁴⁶ Lin, "Legal Ecology of China's Venture Capital Market: Reflection in the American Mirror," 92-93.

⁴⁴⁷ Lerner, Hardyman, and Leamon, *Venture Capital and Private Equity: A Case Book*, 251.

⁴⁴⁸ Joshua Lerner, Ann Leamon, and G Felda Hardyman, *Venture Capital, Private Equity, and the Financing of Entrepreneurship: The Power of Active Investing* (John Wiley & Sons, 2012), 205.

⁴⁴⁹ Lerner, Hardyman, and Leamon, *Venture Capital and Private Equity: A Case Book*, 360-361. Also see, Rousseau, "The Future of Capital Formation for Small and Medium-Sized Enterprises: Rethinking Initial Public Offering Regulation after the Restructuring of Canadian," 669.

Lin observes that the GEM has not been fully utilized yet.⁴⁵⁰ Also, because of the policy of equity division in China, the exit of Chinese domestic VC through the Small and Medium-Sized Enterprises (SME) Board cannot be achieved successfully even after the portfolio firms listed on it.⁴⁵¹

Comparatively, for filling the gaps of the deficiencies of domestic VC markets, without various structures of mature IPO markets, Lu, Tan and Chen suggest pursuing overseas IPOs or learning from the model of Israel, where the firms are able to access foreign inputs and the financial market bridges the international VC industries.⁴⁵² This could only be a temporary solution because there are many other scholars who suggest strengthening the local IPO markets.⁴⁵³

Regardless of the function of exit for VC or PE investors, Lerner, Hardyman and Leamon argue that the invested companies demand a robust public equity market.⁴⁵⁴ On the one side, they explain that only in such a public market, PE investors can credibly commit entrepreneurs to ultimately relinquish the control of the portfolio firm.⁴⁵⁵ On the other side, public equity market is a crucial channel to raise capital for a firm after VC or PE provided it initial fund that may not continue keeping its positive cash flow.⁴⁵⁶ Moreover, going public can send signals of the stability and dependability of the firm to the existing and the potential customers or suppliers.⁴⁵⁷

The empirical study conducted by Gompers et al. shows that VC funds are sensitive to the public equity market signals of investment opportunities.⁴⁵⁸ However, although institutional investors who make transactions in a much higher frequency than individual investors prefer securities with active trading markets, Rousseau reminds that they are reluctant to invest in

⁴⁵⁰ Lin, "Legal Ecology of China's Venture Capital Market: Reflection in the American Mirror," 108.

⁴⁵¹ Ibid. 107.

⁴⁵² Lu, Tan, and Chen, "Venture Capital and the Law in China," 234. 253.

⁴⁵³ Lerner, Hardyman, and Leamon, *Venture Capital and Private Equity: A Case Book*, 103.

⁴⁵⁴ Ibid. 103.

⁴⁵⁵ Ibid. 103.

⁴⁵⁶ Ibid. 359-360.

⁴⁵⁷ Ibid. 360.

⁴⁵⁸ Gompers et al., *Venture Capital Investment Cycle: The Impact of Public Market*, 3.

public SMEs due to the high risk and high transaction costs of illiquidity.⁴⁵⁹ In order to look for issuers in a low degree of information asymmetry and to decrease transaction costs, they would invest in the securities of SMEs that were brought to the public equity market by venture capitalists or high quality auditors and underwriters.⁴⁶⁰

This could be a high standard to meet for many firms,⁴⁶¹ not only for SMEs. The statistics compelled by Barry et al. reveal that only ten percent of IPOs were VC-backed between 1986 and 1987, and on average 28 percent of all IPOs were VC-backed during the period 1978-1987 in the U.S.⁴⁶² However, the statistics also show that the aggregated equity held by VC investors among the firms become larger after their IPOs.⁴⁶³

1.3. International Financial Flows

International financial flows basically have two separate types. One type is foreign direct investment (FDI), which means direct investment in factories, machines and business; the other type is portfolio investment, which is passive investment in bonds or shares without control.⁴⁶⁴

The importance of international financial flows has been realized by many countries, especially in this time of globalization. This phenomenon has been presented in an empirical study conducted by Heffernan and Wachtel, and they also conclude that foreign-owned banks, the lending decisions of which should require hard verifiable information and real estate as collateral in theory, do not lend less to SMEs than private domestic banks do in practice.⁴⁶⁵

Comparatively, FDI is more important with a common consensus of scholars. For example,

⁴⁵⁹ Rousseau, "The Future of Capital Formation for Small and Medium-Sized Enterprises: Rethinking Initial Public Offering Regulation after the Restructuring of Canadian," 712-713.

⁴⁶⁰ Ibid. 713.

⁴⁶¹ Himmelberg and Petersen, "R&D and Internal Finance: A Panel Study of Small Firms in High-Tech Industries." 40.

⁴⁶² Christopher B. Barry et al., "The Role of Venture Capital in the Creation of Public Companies," *Journal of Financial Economics* 27 (1990): 451-454. ("433 IPOs with venture-capital backing and 1,123 IPOs without such backing.")

⁴⁶³ Ibid. 460.

⁴⁶⁴ Greenhalgh and Rogers, *Innovation, Intellectual Property, and Economic Growth*, 244.

⁴⁶⁵ Beck, D. Kunt, and Peria, *Bank Financing for SMEs around the World: Drivers, Obstacles, Business Models, and Lending Practices*, 16.

Greenhalgh and Rogers explain that FDI creates new productive capacity, so it is important to economic growth in a country, and it also brings knowledge and technology.⁴⁶⁶

From the study of the VC investors from San Francisco, New York and Boston, Chen, Gompers, Kovner and Lerner learn that the VC investors from VC center cities can firstly outperform on their non-local investments because of their successful investment models at home cities and their high cost of remote monitoring, even though the success rate of their investments would be reduced after the marginal cost of monitoring decreases.⁴⁶⁷ In the case of Australia, Barkoczy and Edmundson believe that foreign VC investment would be a catalyst for developing the VC market.⁴⁶⁸

When discussing the financial market in China, Lu, Tan and Chen believe that foreign VC funds are more flexible than domestic in exiting their investment to avoid risks, which causes the gap between the performance of foreign and domestic VC funds.⁴⁶⁹ They believe the success of Israeli VC market results from accessing FDI and its technological contribution.⁴⁷⁰ Moreover, their statistics of the source of VC in China also show an increasing importance of FDI, which took 5 percent in 2004 and 43.7 percent in 2006 to become the largest source of VC.⁴⁷¹

During this process, FDI broadens the size and independence of domestic VC markets and instructs the market to be more mature.⁴⁷² However, currently, under the Chinese dual-track system in financial regulations, domestic VC funds are less protected by law than foreign VC funds, which hurts the success of domestic VC funds.⁴⁷³ Also, even if foreign VC funds hold beneficial financial laws in China, they still prefer overseas operation for better legal protection

⁴⁶⁶ Greenhalgh and Rogers, *Innovation, Intellectual Property, and Economic Growth*, 244.

⁴⁶⁷ Henry Chen et al., "Buy Local? The Geography of Successful and Unsuccessful Venture Capital Expansion," *Journal of Urban Economics* 67 (2010): 90–110.

⁴⁶⁸ Barkoczy and Edmundson, "Australasian and South East Asian Venture Capital Tax Expenditure Programs," 62.

⁴⁶⁹ Lu, Tan, and Chen, "Venture Capital and the Law in China," 253.

⁴⁷⁰ Ibid. 234. The authors rank Israel as the second best VC market outside that of the U.S., based on its performance on R&D, GDP, VC availability and technological readiness reported by IMD World Competitiveness Yearbook 2004 and the WEF Global Competitiveness Report 2004.

⁴⁷¹ Ibid. 242.

⁴⁷² Ibid. 250. Foreign VC funds provide more exit channels for early-stage VC investments.

⁴⁷³ Ibid. 262.

there.⁴⁷⁴ Therefore, comparing foreign capital investing Chinese firms through foreign venture capitalists, Lu, Tan, and Chen suggest that China should take care of the investment through domestic venture capitalists more, and then the new corporations would create more investment opportunities for other foreign VC funds.⁴⁷⁵

1.4. Debt

In this section, I will firstly compare two types of financing strategies in their pros and cons to help SMEs find an appropriate path to acquire capital. To explain why the firms prefer debt financing to equity financing, the literature in Section 1.4.2 presents some environmental factors, such as policy and the structure of financial market, which help SMEs easily acquire debt. Furthermore, the literature in Section 1.4.3 explores more effective factors from legal environments and compares the availability of debt for SMEs in civil law countries with that in common law countries.

1.4.1. Debt Financing v. Equity Financing

Although the cost of debt financing is lower than that of equity financing, Levin and Roca argue that PE/VC investors bring to the portfolio companies more than capital, also the firms are more easily acquire loans after invested by PE/VC investors.⁴⁷⁶ Heffernan argues that SMEs are difficult to get any banking services, including getting loans and negotiating the loan rates, in the local markets, and they are treated discriminately in these processes.⁴⁷⁷ The statistics conducted by Himmelberg and Petersen show a low degree of using debt among the 3035 U.S.

⁴⁷⁴ Ibid. 262.

⁴⁷⁵ Ibid. 257.

⁴⁷⁶ Levin and Roca, *Structuring Venture Capital, Private Equity, and Entrepreneurial Transactions*, 1-7.

⁴⁷⁷ S Heffernan, "UK Bank Services for SMEs: Are They Competitively Priced?" *Faculty of Finance Working Paper* 44, 2, accessed June 21, 2016, no. 0 (2003), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=903342.

manufacturing firms from 1983 to 1987.⁴⁷⁸ Precisely, the sum of both short-term loans and long-term loans of these firms on average reaches only ten percent of their average internal finance.⁴⁷⁹

For innovative firms, Mueller and Reize conclude that bank loans are not an optimal method of financing for them because of the lack of collateral, as their R&D expenditures are less likely to transform to tangible assets.⁴⁸⁰ In practice, the empirical study conducted by Hall about U.S. manufacturing firms over the period 1973 to 1989 tells that the firms with high leverage usually were not R&D-intensive firms, so Hall implies that debt may not be an appropriate source of financing R&D for firms, or be necessarily considered in R&D policies.⁴⁸¹

By contrast, Spulber makes a completely opposite standpoint that debt is an optimal structure of financing for improving R&D because moral hazard and limited liability of debt contract can provide firms more incentives to make efficient performance for payoff of the loans, even though firms may also avoid some projects that probably make positive expected value in their business.⁴⁸²

When solely discussing the effectiveness of equity financing by banks, however, Jeng and Wells learn that only the firms having close relationships with banks in Japan and Germany can get equity financing from the banks, and the function of management by the banks is limited.⁴⁸³ Besides the limitation of the function of banks on equity financing, private equity financing itself is not perfect on the effectiveness of financing by SMEs. A survey by Mason and Kwok among 884 SMEs in the U.K. shows that many SMEs are not ready to accept VC investment, so they make limited amount of early stage equity financing.⁴⁸⁴

⁴⁷⁸ Himmelberg and Petersen, "R&D and Internal Finance: A Panel Study of Small Firms in High-Tech Industries," 44.

⁴⁷⁹ Ibid. 44.

⁴⁸⁰ Mueller and Reize, *Loan Availability and Investment: Can Innovative Companies Better Cope with Loan Denials?* 2-4.

⁴⁸¹ Hall, *Investment and Research and Development at the Firm Level: Does the Source of Financing Matter*, 19-20.

⁴⁸² Daniel F Spulber, *Patents Are the Foundation of the Market for Inventions*, 2014, 40, accessed June 21, 2016, http://www.law.northwestern.edu/research-faculty/searlecenter/events/roundtable/documents/Spulber_Patents_and_the_Market_for_Inventions.pdf.

⁴⁸³ Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries," 247.

⁴⁸⁴ Colin Mason and Jennifer Kwok, *Investment Readiness Programmes and Access to Finance: A Critical Review of Design*

If we turn our eyes on the lending function of banks, on the side of lenders, Barkoczy and Edmundson claim that the risk of debt is smaller than the risk of making VC investment because the return is fixed and the only concern of lenders is the ability of debtors to repay the principles.⁴⁸⁵ As every type of financiers has their own solution for information asymmetry problems, Mueller and Reize appreciate that banks use screening techniques and collateral to control their risks on loans.⁴⁸⁶ On the side of debtors, because of the lack of access to public equity markets, they find that bank loans are a more important channel of capital than equity financing to most German SMEs.⁴⁸⁷

1.4.2. Economic Environments of Using Debt

In Germany, banks and SMEs have close, long-term relationships, and Mueller and Reize conclude that this is a result of the bank-based system, in which firms prefer bank loans to equity financing.⁴⁸⁸ Reize finds that bank loans take 31 percent of total external financing sources.⁴⁸⁹ Moreover, Jacobson, Linde and Roszbach recognize that the Interpreting Basel II Accord (Basel Committee, 2004) is particularly designed to encourage small business loans by setting low systematic risk on them.⁴⁹⁰

Outside Germany, the empirical study across several countries, conducted by Giannetti, confirms that unlisted firms were more likely indebted.⁴⁹¹ Jacobson, Linde and Roszbach also recognize that in a relatively long period of the past years bank loans have been the prime source

Issues, 2010, 32, accessed June 21, 2016, <http://strathprints.strath.ac.uk/28042/1/>.

⁴⁸⁵ Barkoczy and Edmundson, "Australasian and South East Asian Venture Capital Tax Expenditure Programs," 58. Also see Winker, "Causes and Effects of Financing Constraints at the Firm Level," 170.

⁴⁸⁶ Mueller and Reize, *Loan Availability and Investment: Can Innovative Companies Better Cope with Loan Denials?* 5.

⁴⁸⁷ *Ibid.* 19.

⁴⁸⁸ *Ibid.* 2.

⁴⁸⁹ *Ibid.* 1.

⁴⁹⁰ T Jacobson, J Lindé, and K Roszbach, "Credit Risk versus Capital Requirements under Basel II: Are SME Loans and Retail Credit Really Different?," *Journal of Financial Services Research*, 2005, 44, accessed June 21, 2016, <http://link.springer.com/article/10.1007/s10693-005-4356-4>.

⁴⁹¹ Giannetti, "Do Better Institutions Mitigate Agency Problems? Evidence from Corporate Finance Choices," 187.

of business finance, especially for SMEs.⁴⁹² Similarly, Berger and Udell find that 86.95 percent of SBA (Small Business Administration) firms in 1994 considered bank loans as their primary financing method.⁴⁹³ On the lenders' side, the statistics of 20 countries by Haselmann and Wachtel shows that smaller banks lend to SMEs more than larger banks and larger banks prefer to lend to larger firms.⁴⁹⁴

Comparatively, Beck, Kunt and Peria observe that banks in developing countries tend to treat SMEs strictly, and they believe that a significant difference between banks in developed and developing countries on the issue of the discriminated availability, interest rates and fees of bank loans to SMEs is caused by the different degree of economic development.⁴⁹⁵ Thus, they suggest adjusting an appropriate lending environment.⁴⁹⁶ Similarly, another empirical study conducted by Kunt and Maksimovic shows that firms in developed countries and large firms have more long-term debts.⁴⁹⁷

Besides to consider the lending environment itself, Giannetti reminds us to count the development of security market into the issue of the availability of both bank loans and market debts because their statistics show that firms are highly indebted in the local market with an underdeveloped stock market.⁴⁹⁸ Precisely, statistical results show that the debt maturity of smaller firms was shorter.⁴⁹⁹ In contrast, public firms, which may be considered good borrowers, are more easily able to access debt and generally access long-term debt in high leverage because

⁴⁹² Jacobson, Lindé, and Roszbach, "Credit Risk versus Capital Requirements under Basel II: Are SME Loans and Retail Credit Really Different?" 43.

⁴⁹³ Allen N Berger et al., "The Economics of Small Business Finance: The Roles of Private Equity and Debt Markets in the Financial Growth Cycle," *Journal of Banking and Finance* 22 (1998): 613-73. Table 2.

⁴⁹⁴ Haselmann and Wachtel, "Institutions and Bank Behavior," 11.

⁴⁹⁵ Beck, D. Kunt, and Peria, *Bank Financing for SMEs around the World: Drivers, Obstacles, Business Models, and Lending Practices*, 3-4.

⁴⁹⁶ Ibid. 15-16.

⁴⁹⁷ Asli Demirguc-Kunt and Vojislav Maksimovic, *Institutions, Financial Markets, and Firms' Choice of Debt Maturity*, 1996, 25.

⁴⁹⁸ Giannetti, "Do Better Institutions Mitigate Agency Problems? Evidence from Corporate Finance Choices," 210-211.

⁴⁹⁹ Ibid. 192.

of their high level of transparency of information reducing the risk of lenders.⁵⁰⁰

Alternatively, Giannetti suggests both developing and developed countries adjusting their creditor protection laws to open this cheap source of external finance.⁵⁰¹ His empirical study finds that the firms in the countries with above average creditor protection are more easily able to have debt financing to invest in their R&D and other intangible assets, or the lenders only prefer short-term debt.⁵⁰²

1.4.3. Legal Environment of Using Debt

After learning from Milhaupt that developing or late development economies often generally favor to use bank-oriented financial policies,⁵⁰³ the empirical study conducted by Kunt and Maksimovic does prove that small firms in bank concentrated countries have more long-term debt than short-term debt.⁵⁰⁴ Actually, they find that small firms in civil law countries are more likely to use it than small firms in common law countries, although large firms do not show such obvious difference.⁵⁰⁵

This result shows that legal system of a country may influence firms choosing the optimal pattern of financing in that country.⁵⁰⁶ Thus, they suggest improving legal effectiveness to benefit all firms in the financial market, and suggest that any sizes of firms in effective legal systems consider long-term debt to be a substitute for short-term debt, even if the liabilities of the latter type of debt is lower.⁵⁰⁷ However, neither can their study prove a correlation between the size of the stock market and financing patterns like debt with samples across both developed

⁵⁰⁰ Ibid. 207-209.

⁵⁰¹ Ibid. 211.

⁵⁰² Ibid. 186, 204, 208.

⁵⁰³ Milhaupt, "The Small Firm Financing Problem: Private Information and Public Policy," 185.

⁵⁰⁴ Demirguc-Kunt and Maksimovic, *Institutions, Financial Markets, and Firms' Choice of Debt Maturity*, 26.

⁵⁰⁵ Ibid. 26.

⁵⁰⁶ Ibid. 26.

⁵⁰⁷ Ibid. 25-27.

and developing countries, nor can it use legal and institutional differences to explain the variation of using long-term debt by firms in their study.⁵⁰⁸

Comparatively, through an empirical study with the samples from 26 European countries from 1993 to 1997 at a firm level, Giannetti finds that in the countries with good creditor protection laws, obtaining loans is easier for the small firms investing in intangible assets.⁵⁰⁹ Also, he proves that the maturity of debt is shorter in the countries where the banking system is concentrated, and the maturity is longer only when the enforcement of laws and creditor protections are better.⁵¹⁰

Moreover, when learning bank behaviors in 20 countries, Haselmann and Wachtel find that banks would prefer SMEs that have information opaque to large enterprises and governments as their debtors in well-functioning legal environments, and, otherwise, banks prefer the latter groups of borrowers.⁵¹¹ Therefore, they conclude that the improvement of legal environment can promote an active capital market for SMEs.⁵¹² Also, the economic model designed by Bottazzi, Rin and Hellmann considers that in developing countries firms using debt by equity investors is associated with the quality of their legal systems.⁵¹³ After they tested with the data of developing countries, they conclude a positive relationship between legal systems and the use of pure debt by VC investors.⁵¹⁴

Comparatively, Lerner and Schoar find that straight debt is relatively less used by PE investors in common law countries, which have better legal enforcement, and the civil law or socialist legal background countries with weaker legal enforcement on control rights of firms are

⁵⁰⁸ Ibid. 26-27.

⁵⁰⁹ Giannetti, "Do Better Institutions Mitigate Agency Problems? Evidence from Corporate Finance Choices," 186.

⁵¹⁰ Ibid. 209.

⁵¹¹ Haselmann and Wachtel, "Institutions and Bank Behavior," 2, 20-21.

⁵¹² Ibid. 2.

⁵¹³ Bottazzi, Da Rin, and Hellmann, "What Is the Role of Legal Systems in Financial Intermediation? Theory and Evidence," 561.

⁵¹⁴ Ibid. 562.

more likely to use debt.⁵¹⁵ However, with the economic analysis of contracts of debt, Gale and Hellwig would argue that debt is an optimal instrument of financing in poor legal systems for information asymmetry problems.⁵¹⁶

2. Interaction of IP and Finance

The literature in this section discusses the interaction of IP and various financial tools that are important to both the economy of a country and the demands of R&D-intensive firms, especially the small and medium-sized ones. After presenting the literature broadly talking about how FDI investors have preferences on strong IP protection first, I then cite some literature to discuss why equity investors need IP regimes to decrease their risks on investments and the relevant transaction costs on information asymmetry and how firms use IPRs to signal and attract these investors. At last, I introduce some studies that argue how IP regimes and creditor protection regimes coordinately affect R&D-intensive firms and their innovation.

While understanding the importance of FDI both in theory of economics and in practice, many countries still have difficulties attracting more FDI because of their immature capital market and limited financial environment, like in China.⁵¹⁷ The traditional view in developing countries is that IP is a significant economic policy, so Olwan implies that providing IP protection should also be important to encourage FDI from developed countries.⁵¹⁸

Moreover, the theoretical models designed by Helpman and Lai argue that strengthening IPR in developing countries can encourage more FDI.⁵¹⁹ Hu and Jaffe agree that fuller IPR

⁵¹⁵ Lerner and Schoar, "Does Legal Enforcement Affect Financial Transactions? The Contractual Channel in Private Equity," 224-225.

⁵¹⁶ Douglas Gale and Martin Hellwig, "Incentive-Compatible Debt Contracts: The One-Period Problem," *The Review of Economic Studies* 52, no. 4 (1985): 650-651.

⁵¹⁷ Lu, Tan, and Chen, "Venture Capital and the Law in China," 250.

⁵¹⁸ Olwan, *Intellectual Property and Development: Theory and Practice*, 348.

⁵¹⁹ Hu and Jaffe, "Lessons from the Economics Literature on the Likely Consequences of International Harmonization of IPR Protection," 101. Also see Edwin L.C. Lai, "International Intellectual Property Rights Protection and the Rate of Product Innovation," *Journal of Development Economics* 55 (1998): 133-53. Also see E. Helpman, "Innovation, Imitation, and Intellectual Property Rights," *Econometrica* 61 (1993): 1247-80.

protection will foster FDI.⁵²⁰ This is reasonable because foreign investors generally invest knowledge and technology beyond capital in their FDI as explained by Greenhalgh and Rogers.⁵²¹

Other scholars also find that investors, mostly the investors of FDI, care about IPRs and make decisions of investment relating to IPRs of the firms and the IPR protection environment where the firms have their business.⁵²² At least, Park and Lippoldt find that “stronger IPRs tend to be associated with higher FDI.”⁵²³ However, while Maskus also admits that FDI is sensitive to international variations in patent rights based on his statistics across both the U.S. and developing countries, he reminds that strong IPRs alone are not enough to attract FDI.⁵²⁴

Similarly, a firm-level survey conducted by Javorcik across both developed and developing countries in 1999 shows that Eastern Europe with strong IPR protection has weaker ability to attract FDI than other developing countries, such as China and Brazil.⁵²⁵ Moreover, she can only confirm the existence of a connection between the strength of IPRs and the incentives of attracting FDI in few industries, such as production facilities.⁵²⁶ Thus, while she implies that the quality and value of the transferred technologies through FDI could be influenced by the strength of IPR protection in host countries, she still argues that both a weak and strong IPR system may deter FDI.⁵²⁷

Chatterjee et al. also make a same conclusion after they combine the arguments in both

⁵²⁰ Hu and Jaffe, “Lessons from the Economics Literature on the Likely Consequences of International Harmonization of IPR Protection,” 107.

⁵²¹ Greenhalgh and Rogers, *Innovation, Intellectual Property, and Economic Growth*, 244.

⁵²² Hu and Jaffe, “Lessons from the Economics Literature on the Likely Consequences of International Harmonization of IPR Protection,” 100. This rational has been testified at least by separated empirical studies of E. Mansfeld, Beata Smarzynska Javorcik, and Phillip McCalman over period of 20 years with the samples across the U.S. and Europe.

⁵²³ Greenhalgh and Rogers, *Innovation, Intellectual Property, and Economic Growth*, 337. Also see W. Park and D. Lippoldt, “Technology Transfer and the Economic Implications of the Strengthening of Intellectual Property Rights in Developing Countries,” *OECD Trade Policy Working Papers*, no. 62 (2008).

⁵²⁴ Maskus, “The Role of Intellectual Property Rights in Encouraging Foreign Direct Investment and Technology Transfer,” 54, 65.

⁵²⁵ Beata Smarzynska Javorcik, “The Composition of Foreign Direct Investment and Protection of Intellectual Property Rights: Evidence from Transition Economies,” in *Intellectual Property and Development: Lessons from Recent Economic Research*, ed. Carsten Fink and Keith E. Maskus (The World Bank and Oxford University Press, 2005), 133–51.

⁵²⁶ *Ibid.* 155.

⁵²⁷ *Ibid.* 159, 134-137.

relative theoretical and empirical literature.⁵²⁸ Interestingly, even though Reichman believes that the relationship between FDI and IPRs is still ambiguous as opinions in the prior literature, he suggests that OECD technology exporters should take this opportunity to enter emerging economies as much as they demand FDI with the unilateral strong IP protection terms for exporters under TRIPs Agreement.⁵²⁹ However, for the benefits of developing countries, Coriat and Orsenigo think that providing strong IPR protection could be effective in attracting FDI relating to R&D despite its high cost, but they also reserve this suggestion because technology developers may use different global business strategies besides FDI.⁵³⁰

Viewing U.S. investors, a survey conducted by Mansfield about 100 U.S. firms from six different manufacturing industries in 1991 shows that stronger IPRs attract their investments in developing countries, especially in R&D activities.⁵³¹ Fuller explains the predicament that foreign VCs, excluding ethnic Chinese foreign venture capitalists, avoid investing in China with its weak IP protection as they prefer to centralize their investment in the countries where formal property rights, such as IPRs, are well protected.⁵³²

“There is an important complementarity between IPRs and financing for innovation,” and Maskus et al. explain this interaction: a significant type of incentives to do risky innovations is to attract bank loans and venture capitalists with their IPRs or trade secrets.⁵³³ On the one side, Maskus believes that IPRs can also indirectly encourage investment, such as FDI, through

⁵²⁸ Sourav Chatterjee et al., “Worldwide: Intellectual Property Rights in Developing Nations,” *NERA Economic Consulting*, 2008, accessed June 21, 2016, <http://www.mondaq.com/unitedstates/article.asp?articleid=57856>.

⁵²⁹ Jerome H. Reichman, “Intellectual Property in the Twenty-First Century: Will the Developing Countries Lead or Follow?,” in *Intellectual Property Rights: Legal and Economic Challenges for Development*, ed. Mario Cimoli et al. (Oxford University Press, 2014), 114.

⁵³⁰ Coriat and Orsenigo, “IPRs, Public Health and the Pharmaceutical Industry: Issues in the Post-2005 TRIPS Agenda,” 227-323. In the developing countries with strong patent protection but small domestic markets, large pharmaceutical companies may concentrate their production facilities in one country but only export to the others. In this case, “the extension of strong IPR regime may hinder FDI.”

⁵³¹ Edwin Mansfield, *Intellectual Property Protection, Foreign Direct Investment, and Technology Transfer*, Discussion Paper 19, 1994, 34. The sample were chose randomly from the industries of chemicals, transportation equipment, electrical equipment, machinery, good and metals.

⁵³² Douglas B. Fuller, “How Law, Politics and Transnational Networks Affect Technology Entrepreneurship: Explaining Divergent Venture Capital Investing Strategies in China,” *Asia Pacific Journal of Management* 27 (2010): 446. Foreign firms founded by ethnic Chinese and embedded in ethnic Chinese communities are called ethnic Chinese foreign venture capital firms. Because of difference of culture, they are distinguished by Fuller from other foreign VCs.

⁵³³ Maskus, Dougherty, and Mertha, “Intellectual Property Rights and Economic Development in China.”

constructing a pro-competitive environment.⁵³⁴ On the other side, Maskus argues that stronger IPRs improve confidentiality, contract maintenance, and monitoring capabilities, so he suggests Lebanon setting a stronger IPR environment to foster both FDI and local investments.⁵³⁵

Heald, however, challenges the empirical results by Mansfield and other conclusions on the positive relationship between strong IP protection and FDI in an under-developed economy.⁵³⁶ The above conclusions could be incomplete if these studies do not separate FDI as the targets in manufacture or research, because foreign investors care less about IP environment when they make decisions on investing in manufacture and facilities.⁵³⁷

Actually, there is a trend for both law scholars and business scholars to discuss that firms are more likely to design various IP strategies relating to finance other than solely rely on the benefits of their patents from the market. For instance, scholars, such as Graham, Sichelman, Kesan, Hsu, and Ziedonis, find that patents are used to send signals of the quality of the technical capabilities of a firm to investors or analysts and attract investors in the capital market.⁵³⁸ In this scenario, regardless of the quality of their patents, empirical evidence by Hsu and Ziedonis shows that the firms in the U.S. semiconductor industry can effectively gain credits from potential and existing investors, especially in their early stage of financing.⁵³⁹

The theoretical rationale of this course of signaling investors is concluded by Long as that patents decrease the cost of information asymmetry between firms and investors in the market, which should be a resource of positive returns of the patents for firms.⁵⁴⁰ Because of the risk of getting undervalued and the aspiration of capital to do innovation, Long believes that signals of

⁵³⁴ Maskus, "The Role of Intellectual Property Rights in Encouraging Foreign Direct Investment and Technology Transfer," 54.

⁵³⁵ Maskus, "Strengthening Intellectual Property Rights in Lebanon," 267.

⁵³⁶ Heald, "Misreading a Canonical Work : An Analysis of Mansfield' S 1994 Study," 314.

⁵³⁷ Ibid. 314.

⁵³⁸ Ted Sichelman and Stuart Graham, "Patenting by Entrepreneurs: An Empirical Study," *Michigan Telecommunication Technology Law Review* 17, no. 1 (2010): 130-132. Also see, Kesan, "Economic Rationales for the Patent System in Current Context," 911-913. Also see, Hsu and Ziedonis, "Resources as Dual Sources of Advantage: Implications for Valuing Entrepreneurial-Firm Patents," 777.

⁵³⁹ See Hsu and Ziedonis, "Patents as Quality Signals for Entrepreneurial Ventures," 4. Their empirical study observes 370 U.S. semiconductor startups which had received VC investment from 1980 to 2005.

⁵⁴⁰ Clarisa Long, "Patent Signals," *University of Chicago Review* 02 (2002): 625-77..

patents to investors are significant for SMEs; otherwise, they burden higher opportunity costs.⁵⁴¹

On the side of firms, the 2008 Berkeley Survey with 1,332 firms finds that some of the important incentives of technology startups to file patent applications are to increase opportunities of securing investment and successful liquidity event, rather than to improve innovate activities.⁵⁴²

On the side of investors, an empirical study conducted by Kortum and Lerner with the samples from twenty U.S. manufacturing industries over a period from the late 1970s to the late 1990s suggests that VC does not only have a strong positive effects on innovations, but also is obviously associated with patent activities.⁵⁴³

Moreover, a survey about 190 VC backed German and British biotech companies, conducted by Häussler et al., shows that patent applications solely reduce the time of successfully acquiring VC investment.⁵⁴⁴ Based on this result, they imply that patent systems can provide effective information for VC investors when they are making investment decisions. Therefore, more scholars, like Reichman et al., infer that small firms may use patents to attract venture capital, and delays in patent examination may cause severe implications for them.⁵⁴⁵

By contrast, the empirical result of a survey conducted by Audretsch et al. around 900 nascent entrepreneurs in the U.S. suggests that the signal effects of patents may only be significant for angel investors and venture capitalists when the entrepreneurs provide or plan to develop a prototype combining with the patent.⁵⁴⁶

Alternatively, Cockburn and MacGarvie predict that the software industry is a totally different story: investors may require early stage firms to file patents as the condition of their

⁵⁴¹ Ibid. 674. In security market, when it is hard to value a firm and its projects, it is more likely that they are to be undervalued. It is usually hard to value the quality and quality of the R&D in a firm, specially a small firm.

⁵⁴² Graham and Merges, "High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey," 1297-1298.

⁵⁴³ Kortum and Lerner, "Assessing the Contribution of Venture Capital to Innovation," 674.

⁵⁴⁴ Carolin Häussler, Dietmar Harhoff, and Elisabeth Müller, *To Be Financed or Not - The Role of Patents for Venture Capital-Financing*, *Business Administration* 8970, 2009, 35.

⁵⁴⁵ Reichman et al., "Intellectual Property and Alternatives: Strategies for Green Innovation," 361.

⁵⁴⁶ David B Audretsch, Werner Bönte, and Prashanth Mahagaonkar, "Financial Signaling by Innovative Nascent Entrepreneurs," *Schumpeter Discussion Papers 2009-001*, no. 7165 (2009): 31.

investing.⁵⁴⁷ Their empirical study around 19,717 public and private software firms between 1990 and 2004 shows that venture capitalists value pending patents more than patents granted in the software industry, which proves the anecdotal evidence that investors are forward-looking.⁵⁴⁸ Under this rationale of investors, if “patent thickets” as the result of a strong IP regime inhibit early-stage software firms to entry the market, these firms are less attractive to investors due to the concern about the transaction costs of anti-commons in this market with larger patent thickets.⁵⁴⁹

The financial cooperation between firms and VC funds is not limited to equity financing but also includes venture lending. After interviewing venture lenders, Ibrahim acknowledges that they value IPRs, such as patents and copyrights, as a substitute for tangible collateral when they lend to start-ups and they have concerns about the protection of downside value of the IPRs.⁵⁵⁰ He finds that in practice, some venture lenders negotiate for the entitlement of the first priority from the IPRs’ sale in their lending contracts with start-ups.⁵⁵¹

Also, Hochberg et al. designed an empirical study about 1,519 U.S. startups and their venture debts from VCs.⁵⁵² They indicate that patents as intangible assets and their exchange can effectively eliminate the impediments in the financial market.⁵⁵³ Precisely, they appreciate that VCs can effectively foster commercialization of patents and increase the liquidity of patent trading in the market. In a process like this, both the market of patent trading and the market of risky debt financing for startups are improved.⁵⁵⁴

For ordinary lenders, IPRs can be important collateral. In the case of the U.S., Article 9 allows them to attach particular collateral or the power to transfer rights in the collateral that the

⁵⁴⁷ Cockburn and MacGarvie, *Patents, Thickets and the Financing of Early Stage Firms: Evidence from the Software Industry*, 43.

⁵⁴⁸ Ibid. 37.

⁵⁴⁹ Ibid. 26-27.

⁵⁵⁰ Darian M. Ibrahim, “Debt as Venture Capital,” *University of Illinois Law Review* 4 (2010): 1187.

⁵⁵¹ Ibid. 1188.

⁵⁵² Hochberg, Serrano, and Ziedonis, *Patent Collateral, Investor Commitment, and the Market for Venture Lending*.

⁵⁵³ Ibid. 8-9.

⁵⁵⁴ Ibid. 2.

debtors have rights in.⁵⁵⁵ Meanwhile, when an owner of an IPR files for bankruptcy, Chapter 11 permits licensing incomes from the executory contract of IPRs held by trustees, regardless of whether trusts assume or reject the contract.⁵⁵⁶ Hence, there are scholars, like Menell, to explore measures to protect lenders from bankruptcy law, contract law, IP laws and relevant policies because he believes that lenders do consider how their attachment of security interests from the IPRs and their relevant interests held by the debtors.⁵⁵⁷

Because the creditor protection laws vary among different states in the U.S., Mann provides empirical evidence showing that stronger creditor rights result in greater flexibility on, and an increased amount of, using patent collateral, especially in the pharmaceutical industry and the software industry.⁵⁵⁸ Ultimately, his statistics show that firms invest more in R&D expenditures, so he concludes that a strengthening of creditor rights to patent collateral fosters innovation by firms through both the patent regime and the creditor protection regime.⁵⁵⁹

3. Government Intervention in the Financial Market

Chapter 1 discusses direct investments by the government in the form of grants and funding. Indirectly, the government also subsidizes firms and their R&D activities through financial markets, so Section 3.1 introduces how the government acts in a venture capital market as an investor coordinating with professional fund managers or through subsidies for this market. Moreover, Section 3.2 discusses how the government subsidies in debt markets are effective in some studies with the experience of different countries.

Other than the direct subsidies in the form of capital, regarding the indirectly supporting

⁵⁵⁵ A security interest is enforceable against the debtor and third parties with respect to the collateral only if: the debtor has rights in the collateral or the power to transfer rights in the collateral to a secured party. U.C.C. section 9-203. (b)(2).

⁵⁵⁶ 11 U.S.C. section 365 (a)&(n).

⁵⁵⁷ Peter S. Menell, "Bankruptcy Treatment of Intellectual Property Assets: An Economic Analysis," *Berkeley Techn. Law J.* 22 (2007): 814.

⁵⁵⁸ William Mann, *Creditor Rights and Innovation: Evidence from Patent Collateral*, 2014, accessed June 21, 2016, <http://fnce.wharton.upenn.edu/profile/1033/>. 22.

⁵⁵⁹ *Ibid.* 2-3.

rules, the government also regulates the financial market. Section 3.3 presents the literature in which the scholars discuss the successes and failures of various policies or regulations on structuring a financial market, which should be efficient to facilitate SMEs to acquire capital to innovate.

3.1. Subsidies and Funding in the VC Market

An important characteristic of the VC market from the experience of the U.S., concluded by Gulinello and Gilson, is that the VC market is emerged and developed as a result of market forces, rather than any policies by the governments.⁵⁶⁰ While the U.S. VC market did not have government assistance or government design in its early stage of development, however, Gilson also admits that other countries could follow a distinguished path from the U.S. Governments to cure the limitation of the market power to solving the simultaneity problem by providing capital and acting as the financial intermediary.⁵⁶¹

On one side, White agrees with this conclusion because financial market has limitations, so it needs government interventions in the form of regulations or subsidies.⁵⁶² For example, the Norwegian government funded PE investments to rebuild its PE market after the banking crisis after the late 1980s.⁵⁶³ Also, Sibbitt recognizes that governments can be both lawmakers and the largest single financial intermediaries to impact on the VC market.⁵⁶⁴

On the other side, extremely, in the perspective of Dent, governments may completely be

⁵⁶⁰ Gulinello, "Engineering a Venture Capital Market and the Effects of Government Control on Private Ordering: Lessons from the Taiwan Experience." 846. Also see, Gilson, "Engineering a Venture Capital Market: Lessons from the American Experience," 1070.

⁵⁶¹ Ibid. 1070. Gilson believes that every country faces the simultaneity problem when it engineers a venture capital market. The core elements of a VC market are capital, specialized financial intermediaries and entrepreneurs, but "each of these inputs will emerge if the other two are present, but none will emerge in isolation of the others." This is the simultaneity problem.

⁵⁶² Lawrence J. White, "Market Failures and Government Failures: Some Cautionary Implications for Financial Reform," in *Sequencing? Financial Strategies for Developing Countries*, ed. Alison Harwood and Bruce L.R. Smith (Brookings Institution Press, 1997), 71-74.

⁵⁶³ Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries," 278.

⁵⁶⁴ Sibbitt, "Law, Venture Capital, and Entrepreneurism in Japan: A Microeconomic Perspective on the Impact of Law on the Generation and Financing of Venture Businesses," 85.

not necessary to be involved into the VC market because well-designed and negotiated contracts can solve the moral hazard issues.⁵⁶⁵ Gilson mentions that governments could effectively engineer a VC market only if they are passive investors to provide funds to the new market but not to participate in the capital allocation process, or they behaving as financial intermediaries can discourage the development of the VC market because their “implicit promise of future funding” could impede the access of private investors to the future funding due to its lack of a mechanism of reputational sanction.⁵⁶⁶ With the failure of the German WFG program, a financial intermediary funded by banks under German government guarantees, Gilson explains the reasons why too many government direct interventions are harmful to the VC market. WFG under the management of government officers has less incentives to make successful investments, does not provide technological or management assistance to the portfolio companies, and has less incentives and ability to monitor the portfolio companies.⁵⁶⁷ Alternatively, he supports governments building a VC environment where funds and specialized intermediaries are available to entrepreneurs.⁵⁶⁸

Unfortunately, furthermore, responding to Gilson’s suggestion of a passive role played by a government on facilitating the development of a local capital market, Zhao and Ziedonis believe that the immature experience of the state of Michigan, the government of which invests in VC funds to support their local firms, provides us an answer of paradox.⁵⁶⁹

Moreover, Milhaupt would argue that direct government interventions, such as subsidies or loan guarantees, are inefficient. Instead, he suggests that governments should only invest in information-related public goods and remove the obstacles of private intermediaries investing to

⁵⁶⁵ George W Dent Jr, “Venture Capital and the Future of Corporate Finance,” *Wash. U. L. Q.* 70, no. 4 (1992): 1044.

⁵⁶⁶ Gilson, “Engineering a Venture Capital Market: Lessons from the American Experience,” 1115-6.

⁵⁶⁷ *Ibid.* 1104-1107.

⁵⁶⁸ *Ibid.* 1116.

⁵⁶⁹ They introduces that the state of Michigan has sponsored two such funds as “fund-of-funds.” One is in 2006 with \$95 million and the other is in 2011 with \$120 million. Zhao and Ziedonis, *State Governments as Financiers of Technology Startups: Implications for Firm Performance*, 9. Also see, “Venture Michigan Fund,” *Merrill Corporation*, accessed May 2, 2015, <http://www.venturemichigan.com/index2.htm>.

bridge private VCs and firms.⁵⁷⁰ He believes that a private equity market creates contractual incentive to monitor their investments.⁵⁷¹ Lerner explains that government officials cannot have effective expertise or resources to monitor portfolio companies because of the lack of experience.⁵⁷²

As a solution, learning from the experience of Japan, Milhaupt suggests that governments can behave as a network builder and a participant in VC market and they can subsidize the information problems of the market by supplying and cooperating with private institutions.⁵⁷³ Alternatively, Lu, Tan and Chen support governments directly funding VC funds rather than controlling them, which can lower the risks and costs of the governments' funding and create incentives of private capital by leveraging them, and they believe that it is particularly significant to design a proper government funded scheme.⁵⁷⁴

A qualitative study about government programs conducted by Jeng and Wells concludes that government funds can play as a catalyst for private sector funding.⁵⁷⁵ Moreover, in the empirical study of the U.S. SBIR program, while Gompers and Lerner did not find a significant difference between government funding and venture capital funding to the awardees, they found that the awardees indeed are more likely to receive investments from VC funds in subsequent years after they acquire government funding.⁵⁷⁶ Actually, besides to induce the development of these specialized intermediaries, for the situation of development countries, Gilson suggests that these governments can be financial intermediaries to invest seed capital to the new market.⁵⁷⁷

Responding to the considerations and the worries of Gilson, that government interventions

⁵⁷⁰ Milhaupt, "The Small Firm Financing Problem: Private Information and Public Policy," 180.

⁵⁷¹ Curtis J. Milhaupt, "The Market for Innovation in the United States and Japan: Venture Capital and the Comparative Corporate Governance Debate," *Nw. U. L. Rev.* 91 (n.d.): 886-887.

⁵⁷² Josh Lerner, "The Government as Venture Capitalist: The Long - Run Impact of the SBIR Program," *The Journal of Business* 72, no. 3 (1999): 289.

⁵⁷³ Milhaupt, "The Small Firm Financing Problem: Private Information and Public Policy," 195.

⁵⁷⁴ Lu, Tan, and Chen, "Venture Capital and the Law in China," 246-7.

⁵⁷⁵ Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries," 243.

⁵⁷⁶ Gompers and Lerner, *The Venture Capital Cycle*, 341.

⁵⁷⁷ Gilson, "Engineering a Venture Capital Market: Lessons from the American Experience," 1104.

may reduce the incentives of investors, Gulinello argues that alternatively they may do not only keep the incentives undamaged but also encourage private transactions on capital by increasing its efficiency.⁵⁷⁸ However, in order to realize the political goals of governments when engineering a VC market, Gulinello reminds them to reconsider the transaction costs created by their subsidies in tax or direct investment, even though their political goals should be more important to be realized than to decrease the transaction costs in the VC market.⁵⁷⁹

In 1986, the Portuguese government created a type of the venture capital corporation in a new structure providing tax benefits, and PE investment in Portugal had a dramatic increase in the following year.⁵⁸⁰ Similarly, the Australian government established Management and Investment Companies (MIC) program in 1983 and Pooled Development Funds (PDF) program in 1992 providing tax incentives to attract investors investing in small firms and medium firms.⁵⁸¹ The Singaporean government uses tax deductions to compensate the losses of VC funds that invest in SMEs to create their investment incentives.⁵⁸² So does the Malaysian government to provide income exemptions for investors who join venture capital funds by special vehicles known as VCCs, regardless of whether the investments are made successful or not.⁵⁸³ With an understanding of these regimes and analyzing the cases of Australia and Singapore, Barkoczy and Edmundson conclude that various forms of subsidies are effective in providing tax incentives to different parties on the VC market, such as the investors or the particular VC funds investing in SMEs, which will ultimately affect the development formal VC markets significantly.⁵⁸⁴

Lu, Tan and Chen agree that tax incentives can influence on both the supply and the

⁵⁷⁸ Gulinello, "Engineering a Venture Capital Market and the Effects of Government Control on Private Ordering: Lessons from the Taiwan Experience," 847.

⁵⁷⁹ Ibid. 869.

⁵⁸⁰ Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries," 277.

⁵⁸¹ Barkoczy and Edmundson, "Australasian and South East Asian Venture Capital Tax Expenditure Programs," 61-62, 73.

⁵⁸² Ibid. 69. Also see, EEI Act, s. 97V.

⁵⁸³ Ibid. 70-71.

⁵⁸⁴ Ibid. 69.

demand side of venture capital in the U.S., and stroke incentives of VC investment and the success of portfolio firms, so they suggest the Chinese government providing tax credits for domestic VC funds to reduce the gap of tax policies between domestic and foreign VC funds.⁵⁸⁵ Also, Lerner, Hardyman and Leamon present empirical evidence supporting that lower tax rates of capital gains attract particular types of investors so as to positively impact on VC fund-raising.⁵⁸⁶ However, considering the probable failure of tax incentives, Rousseau reminds governments to put some weights on the availability of liquidity for the funds.⁵⁸⁷

Alternatively, based on an empirical study of VC investments distributed by geography, in order to take the benefits from established and mature VC markets, Chen et al. suggest that policymakers outside these markets should consider to attract experienced VC investors from these markets instead of to subsidize the existing local investors from their markets.⁵⁸⁸

3.2. Subsidize Debt Financing

In the U.S., the Small Business Innovation Research (SBIC) program was established in 1958 and is administered by the SBA. In an empirical study about 280 SBICs, Brewer et al. show that this program was designed to encourage banks that lend long-term debts to small firms by government guarantees, which resulted in poor performances.⁵⁸⁹ Conversely, the regular interest payment requirements for these equity-oriented SBICs made the SBA burdensome.⁵⁹⁰

Japan also has a similar program, the Venture Enterprise Center, established by the Ministry of International Trade and Industry (MITI) to provide guarantees of the loans for the small firms

⁵⁸⁵ Lu, Tan, and Chen, "Venture Capital and the Law in China," 262, 266-267.

⁵⁸⁶ Lerner, Leamon, and Hardyman, *Venture Capital, Private Equity, and the Financing of Entrepreneurship: The Power of Active Investing*, 103.

⁵⁸⁷ Rousseau, "The Future of Capital Formation for Small and Medium-Sized Enterprises: Rethinking Initial Public Offering Regulation after the Restructuring of Canadian," 713-714.

⁵⁸⁸ Chen et al., "Buy Local? The Geography of Successful and Unsuccessful Venture Capital Expansion," 27.

⁵⁸⁹ Elijah Brewer III et al., "Performance and Access to Government Guarantees: The Case of Small Business Investment Companies," *Econ. Persp.*, 1996, 29.

⁵⁹⁰ *Ibid.* 29.

with an original project. Learning from the experiences of this program and the SBICs, although Sibbitt admits that the government subsidies on debts could reduce the risk and cost of debt financing of venture businesses, he worries that an excessive government involvement and the inefficient management by governments would finally hamper the available investments or loans to venture businesses.⁵⁹¹

The empirical study conducted by Kunt and Maksimovic proves that the level of government subsidies is positively related to the amount of long-term debts lent to both large and small firms, and they infer that one probable reason could be that the subsidies are considered by lenders as implicit guarantees.⁵⁹²

3.3. Regulations or Policies on Financial Markets

Gilson criticizes the political influences of governments on investors selecting portfolio companies because it would probably make negative effects on the likelihood of the success of the VC funds.⁵⁹³ Milhaupt recognizes this conflict of interest when they prove that governments can acquire profits from the investments of information-related public goods.⁵⁹⁴

To the situation of developing countries, Harwood concludes that they need economic and prudential regulations in the transition from a regulated environment to a deregulated one, even though they plan to build market-oriented financial systems rather than government-controlled ones.⁵⁹⁵

In practice, however, government interventions are inevitable. Whenever we consider a legal and tax environment, government direct investment, or any other governments' indirect encouragements on investment, Jeng and Wells remind that governments play a strong role in

⁵⁹¹ Sibbitt, "Law, Venture Capital, and Entrepreneurism in Japan: A Microeconomic Perspective on the Impact of Law on the Generation and Financing of Venture Businesses," 103-104.

⁵⁹² Demirguc-Kunt and Maksimovic, *Institutions, Financial Markets, and Firms' Choice of Debt Maturity*, 26-27.

⁵⁹³ Gilson, "Engineering a Venture Capital Market: Lessons from the American Experience," 1114-1115.

⁵⁹⁴ Milhaupt, "The Small Firm Financing Problem: Private Information and Public Policy," 180.

⁵⁹⁵ Harwood, "Financing Reform in Developing Countries," 6.

influencing the growth of private sources of PE or VC funds because of the experiences of explosion of new VC or PE funds in the U.S., Canada, Ireland, Italy and Finland, where the governments unleashed the obstacles of pension funds or banks' investments in their VC markets.⁵⁹⁶

Taking the example of Taiwan, Gulinello explains that one possibility of the importance of government interventions to an early VC market could be that it trains labors to become the next generation of entrepreneurs.⁵⁹⁷ Moreover, the regulations governing the VC investment in Taiwan of 1983 constructed a framework of venture capitalists.⁵⁹⁸ While these regulations were designed to control the investment decisions of the VC investors, Gulinello observes that the enactment of these regulations did not reduce the incentives of the investors and fund managers because of the strong power of the market, even though the regulations limited some choices of theirs.⁵⁹⁹

Due to financial systems are designed differently as bank-oriented or stock market-oriented,⁶⁰⁰ financial regulations vary among different countries. White points out that some bank-oriented countries, such as Japan, would not develop the information infrastructure to support equity markets as well as the countries with the latter form in their financial systems.⁶⁰¹ Even more seriously, Milhaupt realizes that the policies of "financial repression" in Japan and South Korea against equity-based finance impeded their development of the VC markets.⁶⁰² In contrast, the policymakers in the U.S., a stock market-oriented market, pursue to eliminate

⁵⁹⁶ Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries." 278-280. Around 1980, the U.S. had a large flow of new VC funds after the Employment Retirement Income Securities Act (ERISA) permitted VC investing for pension funds. Many new funds came out in Ireland after its governments encouraged pension funds investing in PE. In 1985, the Research Bank changed its rules to allow Australian banks to make equity investments in SMEs. In the later 1990s, Italian government permitted pension funds to invest in SMEs. In 1995, Finnish governments encouraged banks and pensions to invest in VC so as to result a dramatic increase in VC comparing to that in 1994.

⁵⁹⁷ Gulinello, "Engineering a Venture Capital Market and the Effects of Government Control on Private Ordering: Lessons from the Taiwan Experience," 856.

⁵⁹⁸ Ibid. 868.

⁵⁹⁹ Ibid. 868.

⁶⁰⁰ Milhaupt, "The Small Firm Financing Problem: Private Information and Public Policy," 184.

⁶⁰¹ White, "Market Failures and Government Failures: Some Cautionary Implications for Financial Reform," 70.

⁶⁰² Milhaupt, "The Small Firm Financing Problem: Private Information and Public Policy," 185.

regulatory obstacles to facilitate private intermediaries.⁶⁰³

Milhaupt thinks that the success of the U.S. policy is due to its function of “gradual accumulation of incentive compatible regulation”, which provides limited liability, favorable tax policies and a flexible governance structure, allowance of pension investment and disclosure requirements to promote an active VC and security market.⁶⁰⁴ Based on this successful experience of the U.S., he suggests governments facilitating the development of relevant contract structures on the financial markets.⁶⁰⁵

More objectively, however, Gilson realizes that the U.S. experience may not be completely appropriate to apply to everywhere, especially the developing countries seeking to construct a VC market quickly.⁶⁰⁶ Tracking the pattern of the U.S. but not exactly copying its experience, the success of the Chilean Corporation for the Incentive of Production (CORFU) program provides the evidence that governments should solve the simultaneity problem of engineering a VC market by providing seed capital and facilitating financial intermediaries. In this process, Gilson also reminds that the most valuable piece of the U.S. VC contracting system is its characteristics of providing intense incentives with intense monitoring, not limited to the side of portfolio companies, but also in the side of fund managers for their reputation in the market.⁶⁰⁷

In the branch of securities regulation, Rousseau suggests public policies aiming at enhancing the marketability of the equity of SMEs because he believes that security regulations impact on SME’s ability to raise public equity capital and public policies that enhance the efficiency of an IPO market can encourage the development of a VC market.⁶⁰⁸ Looking into this process, on the one hand, he reminds that the high cost of IPO can inhibit the abilities of

⁶⁰³ Ibid. 188.

⁶⁰⁴ Ibid. 192-3.

⁶⁰⁵ Ibid. 193.

⁶⁰⁶ Gilson, “Engineering a Venture Capital Market: Lessons from the American Experience,” 1104.

⁶⁰⁷ Ibid. 1112-3.

⁶⁰⁸ Rousseau, “The Future of Capital Formation for Small and Medium-Sized Enterprises: Rethinking Initial Public Offering Regulation after the Restructuring of Canadian,” 662, 682, 713, 699.

SMEs from raising capital in this market.⁶⁰⁹ Meanwhile, on the other hand, he saw a high cost on information acquisition for investors in an IPO market, especially small firm IPO market.⁶¹⁰ The two main sources of high cost of a public equity market are market imperfections and the regulations impairing market efficiency, so he strongly suggests that regulators should decrease this high cost, increase the efficiency of the market and modify the market to be more suitable for the demands and characteristics of SMEs.⁶¹¹

In the case of Japan, the regulatory restrictions for stability of the financial market causes lack of dynamic public market, so Sibbitt pushes Japanese governments to deregulate the equity market and improve its diversity, such as facilitating the emergence of a dynamic OTC market.⁶¹² In the case of China, in 2005, the SME Board is established by the State Council to provide a convenient capital-raising environment for SMEs and exit channel for VC investors.⁶¹³ However, Lin criticizes the high requirements of IPOs on the SME Board as it betrays these two goals.⁶¹⁴

Moreover, because the policies improving stock markets in their functioning and liquidity would particularly benefit large firms, Kunt and Maksimovic suggest that policies should improve the development of banking systems to expand the availability of long-term debt to small firms.⁶¹⁵ For the countries like the U.K., where the stock market is not the main stream of financing, Giannetti suggests legislations or governments should make creditor protection laws or policies to improve market development, which affects the power of banks and costs of lending, so as to ultimately affects the maturity of firm debt and its leverage.⁶¹⁶ Furthermore, besides to improve enacted laws, Haselmann and Wachtel suggest that policies should develop

⁶⁰⁹ Ibid. 669.

⁶¹⁰ Ibid. 714.

⁶¹¹ Ibid. 714-716.

⁶¹² Sibbitt, "Law, Venture Capital, and Entrepreneurism in Japan: A Microeconomic Perspective on the Impact of Law on the Generation and Financing of Venture Businesses," 67-70.

⁶¹³ Lin, "Legal Ecology of China's Venture Capital Market: Reflection in the American Mirror," 105.

⁶¹⁴ Ibid. 105.

⁶¹⁵ Demirguc-Kunt and Maksimovic, *Institutions, Financial Markets, and Firms' Choice of Debt Maturity*, 28.

⁶¹⁶ Giannetti, "Do Better Institutions Mitigate Agency Problems? Evidence from Corporate Finance Choices," 195-196.

confidence of lenders in the operation of a legal environment.⁶¹⁷

II. Problems that Remain in the Literature

This part regards three problems that are about the financial market and still remain in the literature. Problem 1 and Problem 2 review the arguments regarding the effects of the other two types of economic instruments of venture capital investment and lending on stimulating innovation by SMEs. In addition to the issues of the voluntary effects from the lending regime itself and its efficiency, Problem 2 also concerns the positive effects of an IP regime on them. Problem 3 is a follow-on question of Problem 1 and Problem 2. It uses China as an example to present the remaining issues in structuring a proper VC market in countries in which this market is immature, especially in developing countries. Problem 4 appreciates other characteristics of these immature markets where the civil law environment creates many criticisms but no effective solutions. This could be avoided after having a better understanding of the previous three problems and the problems discussed in Chapter 2 and Chapter 3.

1. Does VC Stimulate Technical Innovation in SMEs?

Basically, most scholars in finance support that venture capital (VC) provides significant positive effects on innovation, because VC investment can become a crucial resource of capital for the firms in high-tech industries.⁶¹⁸ However, if we look into their studies, their conclusions are still too imprudent as two problems remain. One is the lack of sufficient empirical evidence, especially the empirical evidence from the innovation by SMEs in developing countries, and the other is the ambiguous definition of innovation.

⁶¹⁷ Haselmann and Wachtel, "Institutions and Bank Behavior," 3.

⁶¹⁸ In literature review, Barkoczy and Edmundson, Jeng and Wells, Gilson, Gulinello, Mueller and Reize, Gompers and Lerner present that VC can spur innovation, especially through high-tech industries.

First, if we look into the pioneer empirical study of some U.S. traditional manufacturing industries by Gompers and Lerner,⁶¹⁹ there are some limitations to prove the theory that VC investments can spur technical innovation, although their data were collected both at country-level and at firm-level. When they tried to explore a connection between innovation by the firms and investments in growing firms in the U.S. manufacturing industries, they found a positive correlation between the number of issued patents and the amount of VC investments which were substituted for R&D.

The exact relationship between R&D and VC investment or patent applications and VC investment in this study, however, is still vague because Gompers and Lerner did not control for the number of patent applications and only controlled for the amount of VC investment and the factors relating to R&D⁶²⁰ as independent variables to predict the number of issued patents. Besides that, they did not control for the size of portfolio firms. Hence, it is difficult to apply this result to suggest that other countries should construct or improve their VC market to encourage the innovation by SMEs.

The empirical study by Audretsch et al. controls for the size of portfolio firms to test signaling effects for investors or lenders.⁶²¹ Their study controls for patents granted and prototype rather than R&D expenditure or the number of patent applications in processing as a measure of innovation. Even though this literature indicates that investors make predictions on the profits of the invested startups because of the significant effects of the achieved technical outcomes on financing decisions by lenders or investors, it cannot show how the various external financing resources affect the current innovation or innovation in the future by the firms. Therefore, the relationship between innovation and financing resources shown in this literature could be lagged.

Alternatively, the results of the Poisson regressions for U.S. startup software firms, in the

⁶¹⁹ Gompers and Lerner, *The Venture Capital Cycle*, 273-307.

⁶²⁰ In a series of their regressions, Gompers and Lerner used R&D/sales ratio of industry and federally funded industrial R&D separately to present the degree of R&D expenditures of the firms.

⁶²¹ Audretsch, Bönte, and Mahagaonkar, "Financial Signaling by Innovative Nascent Entrepreneurs."

study by Cockburn and MacGarvie, show a positive relationship between the numbers of pending patent applications and the fund that the firms acquired from venture capitalists, and they imply that investors set patent applications as a condition of funding.⁶²² However, the literature does not mention if this phenomenon also signifies that the conditional investment can stimulate further innovation by the firms and innovation by other firms in the industry.

Except the above two important empirical studies, other scholars either theoretically imply, based on some superficial experiences from some mostly developed countries, that venture capital markets can spur technical innovation in a country,⁶²³ or merely show some statistical results, the data of which are also mostly from developed countries.⁶²⁴ A possible reason could be that developing countries have less evidence to study the variance of VC markets and innovation since both the development of their VC markets⁶²⁵ and innovation are at a relatively low level, so I conducted this study to suggest how developing countries should develop their VC/PE markets so as to potentially spur innovation.

This lack of evidence, however, should not be an excuse to ignore the practical stories of VC markets and innovation in developing countries. From the successful experience of certain developed countries, we learn the importance of encouraging them to structure a VC market. Moreover, we still need to learn from the experience of the developing countries which have developed a relatively successful VC market, such as the VC market in Israel.⁶²⁶

Hence, it is meaningful to expand the study in how VC markets affect innovation in the case of China with both theoretical analysis and empirical evidence, not being limited to its

⁶²² Cockburn and MacGarvie, *Patents, Thickets and the Financing of Early Stage Firms: Evidence from the Software Industry*.

⁶²³ This type of scholars mentioned by our literature review at least includes Barkoczy and Edmundson, Jeng and Wells, Gilson, and Gulinello.

⁶²⁴ The studies presenting statistical evidence are still comparatively less than the former type of theoretical studies. The only one developing country that we know its VC market development and its effects on innovation is Israel.

⁶²⁵ Barkoczy and Edmundson state that many countries other than the U.S., not limited to the developing countries but also including many developed countries, do not have a mature VC market. Barkoczy and Edmundson, "Australasian and South East Asian Venture Capital Tax Expenditure Programs," 56.

⁶²⁶ Actually, Lu, Tan, Chen, Gompers and Lerner, have realized the success of Israeli VC market. However, they did not analyze its success in detail, but only superficially introduce the process of its growth and mentioned some important factors of recourses acquired from foreign investors, without empirical evidence. See, Lu, Tan, and Chen, "Venture Capital and the Law in China." See also, Gompers and Lerner, *The Venture Capital Cycle*.

manufacturing industries, but rather directly applying the rationale of VC and innovation from the experience of developed countries to China and other developing countries.⁶²⁷ If not, the correctness of the advice of the scholars who suggest that developing countries should follow the experience of the U.S. to structure their VC markets with an “extremely efficient contracting structure” could be doubted.⁶²⁸

In the process of this study, I also deal with another remaining question of the previous literature: the definition of innovation that the literature presents is not clear. The defects of the empirical study by Gompers and Lerner provide direct evidence to support the existence of this issue.⁶²⁹ Based on their regressions that merely held the number of issued patents as an explained variable, Gompers and Lerner conclude that VC investments can spur innovation. Obviously, the number of issued patents solely cannot be equal to innovation.⁶³⁰ For example, some firms in the industry of information technology usually do not use patents to protect their results of innovation, but use copyrights or trade secrets.⁶³¹

If instead I use R&D expenditure to present the innovative activities, unfortunately, the definition of innovation is still vague. Gompers and Lerner remind us that if patents are only for attracting investors, VC investments may deter R&D amount at some level.⁶³² Comparatively,

⁶²⁷ The literature, mentioned by literature review, discussing the VC market of China by the scholars, Lu, Tan, Chen, and Zhang, directly applies the theory that VC can spur innovation so as to suggest that Chinese government should apply the experience of the U.S., its structure of the market and law, without testifying the practical situation in China. See Lu, Tan, and Chen, “Venture Capital and the Law in China.” See also, Lin, “Legal Ecology of China’s Venture Capital Market: Reflection in the American Mirror.”

⁶²⁸ In the literature review exploring how developing countries develop a VC/PE market, it shows that some scholars, such as Gilson, Jeng and Wells, Kaplan, Martel and Stromberg, have realized that it should not be practical or appropriate to apply a strict contracting system of the VC markets in developing countries. See Gilson, “Engineering a Venture Capital Market: Lessons from the American Experience.” See also, Jeng and Wells, “The Determinants of Venture Capital Funding: Evidence across Countries.” See also, Kaplan, Martel, and Strömberg, “How Do Legal Differences and Experience Affect Financial Contracts?”

⁶²⁹ Gompers and Lerner, *The Venture Capital Cycle*.

⁶³⁰ Literatur usually uses R&D expenditure, R&D/sales ratio, the number of patent applications, and forward-looking citations to value the degree of innovation and the value of innovation of technology developers.

⁶³¹ Li mentioned that the importance of patents varies among different industries. They could be significant for hardware industries, whereas they may be not that important for software industries. See Li, “Intellectual Property and Innovation: A Case Study of High-Tech Industries in China,” 262. Denicolo and Franzoni explain that technology developers pursue protection of their innovation from trade secrecy or copyrights when their innovation cannot be protected by patents. See also, Denicolò and Franzoni, “Weak Intellectual Property Rights, Research Spill-Over and the Incentive to Innovate,” 129.

⁶³² Gompers and Lerner, *The Venture Capital Cycle*, 275.

when other scholars theoretically conclude that VC investments are important to innovation, although Gompers and Lerner present that R&D activities demand capital from VC investors and VC investors prefer risky businesses that do R&D, they roughly make innovation be equal to R&D expenditures.⁶³³ Not only can their studies not clearly define the ambiguous relationship between R&D activities and VC investments, but their conclusions also conflict with the conclusions of their empirical study, which also adopt a rough definition of innovation.

Hence, there are still no clear answers for the question how VC investments spur innovation in the previous studies. In my empirical study, I try to both independently and jointly explore the effects of VC investments on various activities or incentives of innovation, including R&D activities, R&D incentives, patent activities and copyright activities by SMEs. This result will fill the gap of the relationship between VC investments and R&D activities brought out in the previous literature. Only if we understand the exact relationship between a VC market and innovative activities by SMEs and how the incentives for innovation in SMEs relate to VC investments⁶³⁴, can we reasonably suggest how the Chinese government should improve its VC markets to realize its political goal to encourage technical innovation, especially by SMEs.⁶³⁵

2. What Is a Suitable Lending Regime for R&D-Intensive SMEs with the Aid of an IP Regime?

⁶³³ For example, the studies by Jeng and Wells, Gulinello, Barkoczy and Edmundson, Mueller and Reize, Zhang, and the Chinese scholars from CASTED have this issue. See Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries." See also, Gulinello, "Engineering a Venture Capital Market and the Effects of Government Control on Private Ordering: Lessons from the Taiwan Experience." See also, Barkoczy and Edmundson, "Australasian and South East Asian Venture Capital Tax Expenditure Programs." See also, Mueller and Reize, *Loan Availability and Investment: Can Innovative Companies Better Cope with Loan Denials?* See also, Lin, "Legal Ecology of China's Venture Capital Market: Reflection in the American Mirror."

⁶³⁴ Gompers and Lerner imply that firms use patents to attract VC investment. However, can firms be encouraged to do more R&D because they have enough capital to support their R&D spending from VC investors, as the other theoretical scholars claim that VC investments are important to high-tech industries? See Gompers and Lerner, *The Venture Capital Cycle*, 304.

⁶³⁵ In order to realize the continuous growth of economy, Premier Li Keqiang presented that China should realize the importance of technical innovation and should reform to provide suitable environment for supporting this political goal. "Li Keqiang: Zai Guojia Kexue Jishu Jiangli Dahui Shang De Jianghua(李克强: 在国家科学技术奖励大会上的讲话)[Li Keqiang: Speech at the Conference of Awarding State Science and Technology]," 2015, accessed June 21, 2016, http://www.gov.cn/guowuyuan/2015-01/09/content_2802721.htm.

In the time when the VC markets in many countries are immature,⁶³⁶ bank loans and venture lending are the important alternative capital resources for firms to obtain capital from financial markets.⁶³⁷ How are these capital resources efficiently used by SMEs to do innovation? How do IPRs play a role in a lending market?

Unfortunately, although in the previous literature many scholars show the importance of lending to SMEs,⁶³⁸ at least two critical issues remain, because of which the problems still have no clear and definite answers. The first issue is the gap between bank loans and the R&D spending by SMEs, and the second issue is the conflicts between the lending regime, especially the financial structures of banks, which fit large firms, and the demand of loans by SMEs.

After reviewing the literature, I recognize a gap in the relationship between bank loans and R&D activities by SMEs. On the one hand, bank loans are significant for firms in their R&D activities, which demand high level of cash flows.⁶³⁹ The firms therefore may prefer loans to other types of financing for several reasons. For example, they may believe that loans are relatively cheaper.⁶⁴⁰ Another reason could be that they may be not ready to accept⁶⁴¹ or able to

⁶³⁶ I repetitively cite this claim by Barkoczy and Edmundson because it is an important financial issue faced by many countries so that many scholars study to improve VC market in various countries, not just in developing countries. This financial issue could be relative to the other parts of the whole financial market, and bank loan is an important part in the financial market. Barkoczy and Edmundson, "Australasian and South East Asian Venture Capital Tax Expenditure Programs," 56.

⁶³⁷ Jacobson et al. claim that bank loans are the primary source of business finance, especially for SMEs. See, Jacobson, Lindé, and Roszbach, "Credit Risk versus Capital Requirements under Basel II: Are SME Loans and Retail Credit Really Different?" 43.

⁶³⁸ In the literature review, the scholars who agree on the view point include Mueller and Reize, Mason and Kwok, Jacobson et al., Giannetti, Berger et al., Haselmann and Pwachtel. See Mueller and Reize, *Loan Availability and Investment: Can Innovative Companies Better Cope with Loan Denials?* See also, Mason and Kwok, *Investment Readiness Programmes and Access to Finance: A Critical Review of Design Issues*. See also, Jacobson, Lindé, and Roszbach, "Credit Risk versus Capital Requirements under Basel II: Are SME Loans and Retail Credit Really Different?" See also, Giannetti, "Do Better Institutions Mitigate Agency Problems? Evidence from Corporate Finance Choices." See also, Berger et al., "The Economics of Small Business Finance: The Roles of Private Equity and Debt Markets in the Financial Growth Cycle." See also, Haselmann and Wachtel, "Institutions and Bank Behavior."

⁶³⁹ Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries," 246.

⁶⁴⁰ Scholars generally believe that debt financing is cheaper than equity financing, whereas this does mean debt financing is cheap as Hall reminds. See Levin and Roca, *Structuring Venture Capital, Private Equity, and Entrepreneurial Transactions*. See also, Giannetti, "Do Better Institutions Mitigate Agency Problems? Evidence from Corporate Finance Choices." See also, Mueller and Reize, *Loan Availability and Investment: Can Innovative Companies Better Cope with Loan Denials?* Hall, *Investment and Research and Development at the Firm Level: Does the Source of Financing Matter*, 10.

⁶⁴¹ In the literature review, I have mentioned that Mason and Kwok raise this point of view based on their survey with 884 SMEs in the UK. Mason and Kwok, *Investment Readiness Programmes and Access to Finance: A Critical Review of Design Issues*.

obtain equity financing.⁶⁴²

On the other hand, R&D-intensive SMEs are less likely to obtain or use loans, especially long-term bank loans.⁶⁴³ For SMEs to acquire loans from banks for R&D activities, R&D expenditures are accounted as expenses rather than costs, so they do not increase the value of tangible assets that can be used as collateral for bank loans.⁶⁴⁴ Banks necessarily ask for collateral to control their risks.⁶⁴⁵ As the result of the gap between loans and R&D expenditures, the R&D-intensive SMEs desire loans, but instead they become a group of debtors who are less likely to obtain loans.

Recall the suggestions that scholars provide to governments about how they should construct a better financial structure for raising the possibility that banks or venture lenders lend long-term loans to SMEs.⁶⁴⁶ They usually suggest that governments should construct a better legal environment, with better creditor protections.⁶⁴⁷ However, the obstinate difficulty that impedes R&D-intensive SMEs to obtain loans is that these SMEs are less likely able to provide collateral.⁶⁴⁸ Thus, trying to unilaterally eliminate the bias of lending R&D-intensive SMEs by improving the legal system of finance would not be the most effective solution for this issue.⁶⁴⁹

The solutions by the previous scholars could also be less valuable because they are similar to the structure of the benzene molecule, dragging us back to the origin of my question.

⁶⁴² In the literature review, some scholars, such as Himmelberg and Petersen, remind that IPO to acquire public equity investment has a high threshold so as to be hard to meet by many firms. Himmelberg and Petersen, "R&D and Internal Finance: A Panel Study of Small Firms in High-Tech Industries."

⁶⁴³ For example, the statistic by Himmelberg and Petersen shows manufacturing firms in the U.S. use loans as 10 percent of their average internal finance. Also, Mueller and Reize present that high leverage firms include few R&D-intensive firms. See Ibid. See also, Mueller and Reize, *Loan Availability and Investment: Can Innovative Companies Better Cope with Loan Denials?*

⁶⁴⁴ Ibid. 4.

⁶⁴⁵ Ibid.5.

⁶⁴⁶ In the literature review, the suggestions from most of the scholars are no surprisingly are about this. See Giannetti, "Do Better Institutions Mitigate Agency Problems? Evidence from Corporate Finance Choices." See also, Haselmann and Wachtel, "Institutions and Bank Behavior." See also, Bottazzi, Da Rin, and Hellmann, "What Is the Role of Legal Systems in Financial Intermediation? Theory and Evidence."

⁶⁴⁷ I have mentioned these scholars, including Giannetti, Bottazzi et al., Haselmann and Wachtel.

⁶⁴⁸ Mueller and Reize, *Loan Availability and Investment: Can Innovative Companies Better Cope with Loan Denials?* 4.

⁶⁴⁹ For example, the empirical study by Kunt and Maksimovic cannot prove a correlation between the degree of creditor protection in financial laws and the use of long-term debt. Demircuc-Kunt and Maksimovic, *Institutions, Financial Markets, and Firms' Choice of Debt Maturity*.

Besides that, a valuable study conducted by Giannetti implies that intangible assets invested in by SMEs are helpful to attracting loans, which provides hope to R&D-intensive SMEs.⁶⁵⁰ Actually, beyond a signaling effect to attract lenders, the literature shows, with the evidence of statistics and interviews, that venture lenders in the U.S. value IPRs as a substitute for tangible collateral.⁶⁵¹

In the case of the U.S., Hochberg et al. show with empirical evidence that a lending regime allowing intangible collateral can eliminate the impediments in the lending market and foster patent commercialization, which could be a happy ending for the first issue, the gap between bank loans and innovation by SMEs.⁶⁵² Moreover, Mann also finds empirical evidence to support a positive effect of stronger creditor rights on innovation by firms that use intangible assets as loan collateral for creditors, and to support the effectiveness of state laws strengthening creditor protection in encouraging lenders using patent collateral.⁶⁵³ However, the second issue that the the lending regime is not designed for SMEs as conveniently as for large firms still remains because SMEs hold fewer patents than large firms.

Alternatively, other scholars suggest that government can provide guarantees for SMEs so they could more easily obtain long-term loans from banks.⁶⁵⁴ This process of subsidizing loans for SMEs should be effective in increasing the level of long-term loans for them because it removes the risks on the burden of creditors when SMEs are incapable of providing enough collateral.⁶⁵⁵ Simultaneously, however, the risks are shifted to governments and social welfare. Hence, this unfortunately could not become an optimal solution as so many scholars criticize

⁶⁵⁰ Giannetti, "Do Better Institutions Mitigate Agency Problems? Evidence from Corporate Finance Choices." 186.

⁶⁵¹ Ibrahim, "Debt as Venture Capital." See also, Mann, *Creditor Rights and Innovation: Evidence from Patent Collateral*. See also, Hochberg, Serrano, and Ziedonis, *Patent Collateral, Investor Commitment, and the Market for Venture Lending*.

⁶⁵² Ibid.

⁶⁵³ Mann, *Creditor Rights and Innovation: Evidence from Patent Collateral*.

⁶⁵⁴ The U.S. SBIC program and Japanese Venture Enterprise Center provide government guarantees for SMEs to support their applications for long-term loans. See Brewer III et al., "Performance and Access to Government Guarantees : The Case of Small Business Investment Companies." See also, Sibbitt, "Law, Venture Capital, and Entrepreneurism in Japan: A Microeconomic Perspective on the Impact of Law on the Generation and Financing of Venture Businesses."

⁶⁵⁵ Demirguc-Kunt and Maksimovic, *Institutions, Financial Markets, and Firms' Choice of Debt Maturity*.

how inefficient it is.⁶⁵⁶

In my research, I concern the interaction of IP and finance in the previous literature, which is unfortunately only in a small amount. For a further research, I explore innovative solutions for effectively financing R&D-intensive SMEs through an IP regime, not limited to the financial regulations and policies. Instead of relying on the empirical evidence by Giannetti's study about European firms or by the study of Mann and Hochberg et al. about U.S. firms, I use the data from the Chinese market to fill the gap in China and other developing countries where the financial markets and relative laws are immature.⁶⁵⁷

Although a gap between loans and SMEs exists,⁶⁵⁸ either in a mature or an immature financial market, my second issue is more serious in developing countries.⁶⁵⁹ Hence, after understanding the specific gap between bank loans and the R&D expenditure by SMEs, it is essential to broaden the view to the whole picture of the financial market: lending regimes are usually designed for large firms, and governments, investors and lenders usually neglect SMEs, which have difficulties obtaining capital under these financial structures.⁶⁶⁰

In sum, for my second issue about the lending regime with SMEs, any solutions directly targeting it may be not effective or not efficient. In contrast, in my research, when studying how the financial structure of banks in China disfavors SMEs, I also study how the financial structures of private and public equity markets help SMEs obtain capital to do innovation.

If VC/PE investments, venture lending or IPO can be proven to be more suitable for SMEs, especially R&D-intensive SMEs, than debt financing from banks, it should be not necessary to

⁶⁵⁶ For example, Brewer et al. criticize the bad performance of the small firms with long-term debts by government guarantees. Also, because of the inefficiency of loan guarantees, Milhaupt suggests that governments should facilitate the development of VC market. See Brewer III et al., "Performance and Access to Government Guarantees : The Case of Small Business Investment Companies." See also, Milhaupt, "The Small Firm Financing Problem: Private Information and Public Policy."

⁶⁵⁷ Lu, Tan, and Chen, "Venture Capital and the Law in China," 250.

⁶⁵⁸ Milhaupt recognized this financial structure issue when he studied with the U.S. firms in the U.S. financial market. Milhaupt, "The Small Firm Financing Problem: Private Information and Public Policy."

⁶⁵⁹ As the literature review presents, banks in developing countries are less likely provide SMEs long-term debt under the studies by several scholars. See Beck, D. Kunt, and Peria, *Bank Financing for SMEs around the World: Drivers, Obstacles, Business Models, and Lending Practices*. See also, Demirguc-Kunt and Maksimovic, *Institutions, Financial Markets, and Firms' Choice of Debt Maturity*.

⁶⁶⁰ Milhaupt, "The Small Firm Financing Problem: Private Information and Public Policy," 184.

construct the financial structure of banks for their accessibility of long-term loans or to encourage the inefficient government guarantees. If this cannot be proven, besides all the above-mentioned exterior and interior factors of the firms relating to the financial system itself,⁶⁶¹ I also try to explore other potentials of the SMEs under the IP regime so that they could solve the puzzle of financing by themselves through innovation that also demands financing to be continuous.⁶⁶²

3. How to Structure an Appropriate VC Market in China?

Following on Problem 1 and Problem 2, if VC/PE investments are more suitable for SMEs to obtain capital than debts, how should a country structure its VC market to improve the market for spurring innovation? This becomes an important problem to many developing countries and investors from developed countries.

The development of the VC/PE market in the U.S. and some other developed countries is excessive, almost saturating the markets, so the incentives of investors⁶⁶³ become limited and the development of the markets becomes imbalanced.⁶⁶⁴ Investors thus turn their attention to the capital markets in developing countries in search of new opportunities and higher returns.⁶⁶⁵

Responding to these expectations of investors, the VC/PE markets in developing countries are inevitably risky.⁶⁶⁶ Meanwhile, many developing countries still puzzle over how they can

⁶⁶¹ Financial laws and government guarantees are considered as exterior factors of firms. The assets as collaterals of firms are interior factors of the firms.

⁶⁶² When explaining the reason why VC investments are important, Mueller and Reize mention that continues R&D activity in SMEs require a huge amount of capital. Mueller and Reize, *Loan Availability and Investment: Can Innovative Companies Better Cope with Loan Denials?* 21.

⁶⁶³ The investors here are not discriminated by VC/PE/institutional investors.

⁶⁶⁴ The bomb growth of the PE market in the U.S. in the past 30 years started to create bubbles. Also, as the PE market is growing so as to increase the income of fund managers, investors worry that the incentives of fund managers may be less effectively. Lerner, Hardyman, and Leamon, *Venture Capital and Private Equity: A Case Book*, 242.

⁶⁶⁵ Surveys of limited partnerships of PE funds show that many largest institutional investors, such as Goldman Sachs and Frank Russell Capital, are increasing their international investment. In 2010, the average level of making investments in Asian emerging markets reached 22% of their investments. The investors pursue risk investments in developing countries. Ibid. 242-3.

⁶⁶⁶ Recall that Lu et al., Barkoczy and Edmundson tell that mostly the VC/PE markets in developing countries are

structure an appropriate VC/PE market by financial policies or laws, not only to attract foreign investors, but also to ultimately foster the growth of their domestic VC/PE funds and domestic firms.⁶⁶⁷ However, in order to answer this question, there are an aggregate of other questions that should be understood.

The first basic question for a country is to understand whether its financial market is a bank-oriented market, an equity market-oriented market, or in between. This is a process of self-awareness, to understand what style of financial policies the country currently adopts on the financial market.⁶⁶⁸ This is important because bank-oriented financial systems may impede the development of VC/PE markets through their regulations or policies, recalling the failed experiences of Japan, Korea and Germany.⁶⁶⁹

Although the differences in financial policies and financial regulations in different styles of markets should be extremely clear so as to help to recognize the type of financial system easily,⁶⁷⁰ with the development of financial markets and globalization of financial activities, the original clear balance could be disturbed. For example, China establishing its financial market through state-owned banks is encouraging the development of a “multi-layer capital market system.”⁶⁷¹ To fill the gap between capital and SMEs, the Chinese government directly invests in SMEs, indirectly invests in SMEs through private VC funds, or provides indirect funds to

immature. Also, the importance of structuring an appropriate VC/PE market has been presented by many scholars' literature that this research has reviewed. See Bottazzi, Da Rin, and Hellmann, “What Is the Role of Legal Systems in Financial Intermediation? Theory and Evidence.” See also, Lerner and Schoar, “Does Legal Enforcement Affect Financial Transactions? The Contractual Channel in Private Equity.” See also, Kaplan, Martel, and Strömberg, “How Do Legal Differences and Experience Affect Financial Contracts?” See also, Jeng and Wells, “The Determinants of Venture Capital Funding: Evidence across Countries.” See also, Lerner, Hardyman, and Leamon, *Venture Capital and Private Equity: A Case Book*. See also, Lu, Tan, and Chen, “Venture Capital and the Law in China.”

⁶⁶⁷ From the experience of Israel and China, Lu et al. show that the access of FDI facilitates the growth of the local VC markets. Ibid.

⁶⁶⁸ Recall the section of regulations or policies on financial markets in the literature review. Milhaupt claims that financial systems are designed as bank-oriented or stock-oriented. Milhaupt, “The Small Firm Financing Problem: Private Information and Public Policy.”

⁶⁶⁹ In the literature review, White, Milhaupt, Jeng and Wells use the experience of Japan, Korea and German show how these countries with bank-oriented market obstruct the development of VC market. See White, “Market Failures and Government Failures: Some Cautionary Implications for Financial Reform.” See also, Milhaupt, “The Small Firm Financing Problem: Private Information and Public Policy.” See also, Jeng and Wells, “The Determinants of Venture Capital Funding: Evidence across Countries.”

⁶⁷⁰ “The choice of financing vehicle differs between developed and developing countries.” See Lerner, Hardyman, and Leamon, *Venture Capital and Private Equity: A Case Book*, 249.

⁶⁷¹ Lu, Tan, and Chen, “Venture Capital and the Law in China,” 254.

SMEs through loans and guarantee programs.⁶⁷² Meanwhile, without any prohibitions, venture lending with collateral of patents and copyrights in China is liberal and increasingly important in the finance market.⁶⁷³ Hence, it is too complicated to simply define a financial system like this as bank-oriented or equity market-oriented.

After recognizing and clarifying the style of the financial policies and financial regulations in a particular financial system, the second question that the developing countries under circumstances like China should consider is how these countries should deal with the conflicts in the financial policies and financial regulations designed for the two different purposes. Since developing countries lack the information infrastructures to support an equity market-oriented financial system,⁶⁷⁴ in order to develop a VC market, they need to understand: how valuable is the experience of developed countries to them?

The literature discussed in the literature review indicates that it might not be appropriate to directly apply the successful model of the U.S., and suggests that the governments of developing countries should facilitate engineering their VC markets.⁶⁷⁵ However, although the literature discusses the efficiencies of governments intervening in the VC markets as fund investors, or bridging VC funds and firms through tax credits, subsidies, grants or financial policies,⁶⁷⁶ the

⁶⁷² Ibid. 245-246.

⁶⁷³ In China, patent and copyright pledge increase times since 2008 when SIPO started promoting them. In 2010, the 362 copies of registered patent pledges valued ¥70.66 hundred million RMB. Zhongguo Guojia Zhishi Chanquan Ju(中国国家知识产权局)[State Intellectual Property Office of the P.R.C.], *Zhuanli Tongji Jianbao*(专利统计简报)[*Patent Statistic Report*]-No. 108, 2011.

⁶⁷⁴ Milhaupt believes that most developing countries have this issue. Milhaupt, "The Small Firm Financing Problem: Private Information and Public Policy," 185.

⁶⁷⁵ "It is often unclear where to begin the process of duplicating the success of the U.S." Hence, Lerner et al. suggests that well-targeted government efforts can play an important and positive role." See Lerner, Hardyman, and Leamon, *Venture Capital and Private Equity: A Case Book*. 103. Moreover, recall the simultaneity problem. Gilson suggests that developing countries can consider involving government assistances to start to structure their VC market, which is differently from the VC market in the U.S. with little government involvement but a pure contracting system. See Gilson, "Engineering a Venture Capital Market: Lessons from the American Experience."

⁶⁷⁶ Recall the literature review. Cumming, Johan, Gomper and Lerner believe that governments acting as VC fund investors are less efficient than professorial VC managers, and Milhaupt believes that the subsidies provided by governments on the VC markets are inefficient. Comparatively, Gulinello, Sibbitt, White, Jeng and Wells, Lu et al., Lerner et al., Barkoczy and Edmundson support governments to fund or subsidize so as to structure the VC markets. See Cumming and Johan, "Phasing Out an Inefficient Venture Capital Tax Credit." See also, Gompers and Lerner, *The Venture Capital Cycle*. See also, Milhaupt, "The Small Firm Financing Problem: Private Information and Public Policy." See also, Gulinello, "Engineering a Venture Capital Market and the Effects of Government Control on Private Ordering: Lessons from the Taiwan Experience." See also, Sibbitt, "Law, Venture Capital, and Entrepreneurism in Japan: A Microeconomic Perspective on the

scholars usually merely cite the successful experiences from the U.S. and other developed countries, but do not suggest how the governments of developing countries could deal with the conflicts between their situation and the experience of developed countries. This ignored question could be the real gap between theoretical suggestions regarding financial policies and the performance in practice by each financial system.⁶⁷⁷

Recall the discussion of financial policies and financial regulations in the literature review. Some governments with an equity-oriented market, such as the U.S., Canada, Ireland, Italy and Finland, design policies that prohibit investing pension funds or banks' investments in the VC market,⁶⁷⁸ and some governments of bank-oriented market countries, such as Germany, France and Japan, encourage the development of both private and public equity markets through the capital from banks.⁶⁷⁹ These conflicts between the two types of financial systems could form significant obstacles to impact the efficiency of a VC market.⁶⁸⁰

For example, in the case of China, a developing country with an emerging VC market,⁶⁸¹ its laws allow insurance companies to be VC/PE investors,⁶⁸² but still sets rigid bars to restrict

Impact of Law on the Generation and Financing of Venture Businesses." See also, White, "Market Failures and Government Failures: Some Cautionary Implications for Financial Reform." See also, Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries." See also, Barkoczy and Edmundson, "Australasian and South East Asian Venture Capital Tax Expenditure Programs." See also, Lu, Tan, and Chen, "Venture Capital and the Law in China." See also, Lerner, Hardyman, and Leamon, *Venture Capital and Private Equity: A Case Book*.

⁶⁷⁷ On the side of criticism, these studies use empirical evidence to criticize the efficiencies of these government intervening behaviors or criticize them through the failure experiences, such as Germany or Japanese experiences. Comparatively, on the side of supporting, the scholars usually take the successful experiences from other countries, especially the U.S., without any empirical evidence.

⁶⁷⁸ Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries," 278-280.

⁶⁷⁹ Recall the study by Jeng and Wells, Lu et al., and Jacobson et al. See, *Ibid.* See also, Lu, Tan, and Chen, "Venture Capital and the Law in China." See also, Jacobson, Lindé, and Roszbach, "Credit Risk versus Capital Requirements under Basel II: Are SME Loans and Retail Credit Really Different?"

⁶⁸⁰ I consider the efficiency on growth of economy through spurring innovation and financing SMEs, which the introduction and the literature review has been discussed. See, Metrick and Yasuda, *Venture Capital & the Finance of Innovation*. See also, Gulinello, "Engineering a Venture Capital Market and the Effects of Government Control on Private Ordering: Lessons from the Taiwan Experience." See also, Gilson, "Engineering a Venture Capital Market: Lessons from the American Experience."

⁶⁸¹ The VC market in China has entered an new strategic stage after China's 12th Five-Year Plan (2011-2015). Shouren Wang (王守仁), "Zhongguo Chuangtou Yixian Xin Geju(中国创投业已现新格局)[The VC Market in China Have Shown Up a New Pattern]," 2011, accessed June 21, 2016, <http://www.chinavalue.net/Investment/Article/2011-5-19/195172.html>.

⁶⁸² P.R.C. Insurance Law [中华人民共和国保险法](effective Feb. 28th 2009), Article 106.

VC/PE investments by banks,⁶⁸³ not just limited to the VC/PE investments from its state owned banks.⁶⁸⁴ Moreover, after learning from the experience of the U.S., China revised its Corporate Law and allowed investors to use convertible preferred stocks in their investments in portfolio companies,⁶⁸⁵ but still limits the stock options to be only the privilege of public companies.⁶⁸⁶ However, in practice, Chinese domestic VC funds do not often use convertible preferred stocks in their investments.⁶⁸⁷

In this circumstance, instead of solely introducing the experience of other countries, I follow the methodology of the earlier literature and test the effectiveness of the various types of government funding or subsidies in the financial market of China with empirical evidence. Then, I review the financial policies and financial regulations in this particular financial market to understand its current structure. Based on the empirical results and the understanding of the current financial system in China, it is time to select and then apply the experience of other countries. Also, the empirical evidence and the understanding of the current financial system can help to explain the reasons why there could be a gap between some financial policies and their enforcement, and ultimately help the Chinese government to understand how the government can structure an appropriate VC market.

As the speed of VC market development in many countries is fast,⁶⁸⁸ this model of analysis will help both the countries with a successful VC market and those with a relatively

⁶⁸³ Law of the P.R.C. on Commercial Banks [中华人民共和国商业银行法](effective Dec. 27th 2003), Article 43.

⁶⁸⁴ Law of the P.R.C. on the People's Bank of China [中华人民共和国中国人民银行法](effective Dec. 27th 2003) Chapter 2.

⁶⁸⁵ Corporate Law[公司法](effective Jan. 1th 2006) Article 35, 167.

⁶⁸⁶ In China, there are no enacting laws to authorize option rights in private firms. Guantao Dalian Bangong Shi(观韬大连办公室)[Guantao Legal Office in Dalian], Yandi Liu(刘燕迪), and Xiaodong Bi (毕晓东), “Guanyu Fei Shangshi Gongsi Guquan Jili Xiangguan Falv Wenti(关于非上市公司股权激励相关法律问题)[Legal Issues about Option Rights Incentives in Private Companies],” 2014, accessed June 21, 2016, <http://www.guantao.com/html/yewuguanli/2014nianlvshiyewubeiwanlu/2014/1208/25936.html>. See also, Lin, “Legal Ecology of China's Venture Capital Market: Reflection in the American Mirror.” 101.

⁶⁸⁷ Ibid.

⁶⁸⁸ From the statistic by Preqin, we know that the amount of global PE and VC asset investments were reached a new high as of June 2014 in \$ 3.8 trillion. The capital in the pool of 994 PE/VC funds reached \$496 trillion. 2014 also saw a \$128 billion increase in dry powder since Dec. 2013. Also, the researchers of Preqin are positive to predict the VC/PE market in 2015. Preqin, *2015 Preqin Global Private Equity & Venture Capital Report*, 2015, accessed June 21, 2016, private-equity-venture-capital-report/1/10599.

immature VC market. The former type of countries can understand their current efficiency through this model, and the latter type can understand the efficiency of their financial policies better and find appropriate financial policies to effectively facilitate their VC market.

4. Difficulties in Learning from American VC Experience for Civil Law Countries

After Problem 3, we understand how China and other civil law countries structure their VC markets through selectively learning from the successful experience of some developed common law countries, such as the U.S. However, in this process of applying the American experience with its VC market, these countries face many difficulties. For example, the domestic Chinese VC funds do not use convertible preferred stocks, which are allowed by the Corporate Law of China. Hence, it is necessary for civil law countries to consider how they can approach these difficulties as an extension of Problem 3.

In the literature, the scholars have criticized the inefficiency of the financial markets in civil law countries,⁶⁸⁹ but it is not sufficient to help the countries by merely making them realize the weaknesses of their legal culture and emphasizing the success of the American VC market.⁶⁹⁰ Moreover, there is an obvious conflict between the criticisms of the poor legal enforcement in the civil law countries and the suggestions that these countries should learn from the American's contracting system. This means that, if their worries are true based on their statistics,⁶⁹¹ their

⁶⁸⁹ Lerner and Schoar, Bottazzi et al., and Kaplan et al. have proved the inefficiency issue by theories and empirical evidence. See Lerner and Schoar, "Does Legal Enforcement Affect Financial Transactions? The Contractual Channel in Private Equity." See also, Bottazzi, Da Rin, and Hellmann, "What Is the Role of Legal Systems in Financial Intermediation? Theory and Evidence." See also, Kaplan, Martel, and Strömberg, "How Do Legal Differences and Experience Affect Financial Contracts?"

⁶⁹⁰ Recall the research done by Kaplan and Stromberg, Kaplan et al., Lerner and Schoar, Jeng and Wells, Bottazzi et al., and Gilson. See Kaplan and Stromberg, "Financial Meets Theory Contracting An Empirical the Real World : Of Venture Analysis Capital Contracts." See also, Kaplan, Martel, and Strömberg, "How Do Legal Differences and Experience Affect Financial Contracts?" See also, Lerner and Schoar, "Does Legal Enforcement Affect Financial Transactions? The Contractual Channel in Private Equity." See also, Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries." See also, Bottazzi, Da Rin, and Hellmann, "What Is the Role of Legal Systems in Financial Intermediation? Theory and Evidence." See also, Gilson, "Engineering a Venture Capital Market: Lessons from the American Experience."

⁶⁹¹ Lerner and Schoar find that the return of PE funds in common law developing countries was on average 19% higher than that in civil law developing countries in 2004. Lerner and Schoar, "Does Legal Enforcement Affect Financial Transactions? The Contractual Channel in Private Equity," 224.

suggestions are less valuable for these civil law countries to structure an efficient VC market.

After following the process of answering the series of questions in Problem 3, the civil law countries should have knowledge of the efficiency of their current financial system, the effectiveness of the current financial policies and financial regulations, and the demands of the VC market from the governments and their legal systems. Even though my research is not going to provide a better solution for the civil law countries, especially the civil law developing countries, than the previous scholars, I construct an analyzing process to help these countries to clarify their financial situations.

This process does not mean declining to learn from the successful experience of the U.S. and other common law developed countries. Instead, in addition to suggesting that civil law developing countries should enhance their contract enforcement for tens years,⁶⁹² they can turn to other approaches to stimulate the incentives of VC investments and to fix the issue of poor enforcement. For example, recall what the IP literature suggests on IP strategies.⁶⁹³ The scholars appreciate that a significant function of IPRs is their signaling effects on attracting VC investors and lenders, especially venture lenders. This drags us back to Problem 2 and the problems discussed in Chapter 3, and my research actively explores solutions in these ways.

Alternatively, besides the access of the VC market, civil law countries can strengthen their IPO markets because IPO is a crucial exit mechanism for VC investments.⁶⁹⁴ Meanwhile, in the literature, there is empirical evidence on how IPOs and a well-structured security market are critical to the incentives of VC investment by VC investors.⁶⁹⁵ Hence, this study also evaluates

⁶⁹² For example, the study done by Lerner and Schoar was in 2005. Ibid. The study done by Cumming and Johan in 2010 also reminds the risks of legal environment for PE investors. Cumming and Johan, "Phasing Out an Inefficient Venture Capital Tax Credit."

⁶⁹³ Ziedonis, "Chapter 10. Intellectual Property and Innovation." See also, Graham and Sichelman, "Why Do Start-Ups Patent." See also, Hsu and Ziedonis, "Resources as Dual Sources of Advantage: Implications for Valuing Entrepreneurial-Firm Patents." See also, Hsu and Ziedonis, "Patents as Quality Signals for Entrepreneurial Ventures." See also, Long, "Patent Signals."

⁶⁹⁴ Rousseau, "The Future of Capital Formation for Small and Medium-Sized Enterprises: Rethinking Initial Public Offering Regulation after the Restructuring of Canadian." See also, Black and Gilson, "Venture Capital and the Structure of Capital Markets: Banks versus Stock Markets."

⁶⁹⁵ Gompers and Lerner, *The Venture Capital Cycle*. See also, Jeng and Wells, "The Determinants of Venture Capital

the efficiency of IPOs in encouraging VC investment in China, which is a civil law developing country and has unsolved difficulties in its VC market alone.

Hence, when I choose to look into a VC market in a civil law developing country, China, my analysis does not limit us to the VC market, but also focuses us on other relevant factors in both its financial market, including in debt, private equity and public equity, and its IP regime. In order to overcome the previous criticisms on the inefficiency of its legal system in fostering the development of the VC market, it is necessary to comprehensively learn about various financial instruments in China.

III. Research Questions and Hypotheses

Based on the above discussion of the issues that remain in the prior literature, this study structures these issues into the concerns with respect to financing, patenting and their interactions. What is the efficiency of external financing, including equity investment and debt, in stimulating innovation by SMEs when China is structuring a multi-layer capital market system? Among local private venture capitalists, state-owned enterprises (SOEs) investors, foreign investors, initial public offerings (IPOs), which are the effective resources to induce SMEs to conduct R&D and improve their R&D commercialization? What is the patenting propensity of SMEs, which are indebted with mortgage or credits, or invested by the above investors, on utility patents and utility models?

Are SMEs' access and needs on debt, both in long-term and in short-term, associated with grants and tax credits from governments and the other forms of external financing acquired by SMEs, such as private investment and public investment? Taking account the effects of those external financing resources, while banks do not usually accept patents as collateral from SMEs,

Funding: Evidence across Countries." See also, Gulinello, "Engineering a Venture Capital Market and the Effects of Government Control on Private Ordering: Lessons from the Taiwan Experience." See also, Sibbitt, "Law, Venture Capital, and Entrepreneurism in Japan: A Microeconomic Perspective on the Impact of Law on the Generation and Financing of Venture Businesses." See also, Lin, "Legal Ecology of China's Venture Capital Market: Reflection in the American Mirror."

are they prefer to lend the SMEs acquiring more patents, under the government policy that encourages banks to accept patents as collateral?

One hypothesis is that both private and public investors can induce SMEs to conduct R&D, and VCs, FDI and IPOs can improve their R&D commercialization. The second hypothesis is that the indebted SMEs are less likely to file more utility patent and utility model applications for saving costs, but the SMEs invested by VCs, foreign investors and public investors are more likely to file the two types of patent applications.

The third hypothesis is that loans, grants and subsidies from governments, and other external financing measures, including private investment from VCs, SOEs and FDI and public investment, are substitute of SMEs' demand for capital. The last hypothesis is that lenders prefer to lend the SMEs acquiring more utility patents or utility models.

IV. Data and Methodology

As the previous two chapters, this part introduces the financial data that are adopted in the research and the methodology to employ the data. Since this chapter also explores the research questions with respect to innovation, IP and government subsidies, to remind, those data have been introduced either in Chapter 2 or Chapter 3. Besides the data with respect to IPRs and innovation both at country-level and at firm-level, to overcome the deficiencies of the probably indirect relationship discussed in the literature review in addition to Chapter 4, section 1 introduces the collected data of professional financial institutions. Section 2 introduces the methodology employing the data.

1. Data and Data Sources

Chapter 2 introduces the background of the observations from Zhongguan-Cun Science Park and Zhangjiang Hi-Tech Park. The data in this chapter are from the same group of

observations in the previous two chapters. For the research questions in this chapter, the data are selected at both the country-level and the firm-level. The range of the data is from 2009-2013. Section 1.1 introduces the country-level data in finance and their sources, and Section 1.2 introduces the firm-level data in finance and their sources.

1.1. Country-Level Data in Finance

Learn from the literature review, the research question in Chapter 3 on exploring a direct connection between the IP regime and technical innovation by SMEs may not have a simple and direct answer, but is disrupted by some financial activities by SMEs. Hence, in order to understand this question and other extended research questions based on this, it is necessary to research the financial data between 2009 and 2013 to understand the financial market, the financial activities by SMEs and their interaction with technical innovation and IP.

The country-level data reflect the variance of the financial market. To be concrete, the financial market here only means VC or PE market, and the debt activities by SMEs will be explored by the firm-level data.⁶⁹⁶

First, because Gilson and some other scholars agree that developing countries need intermediaries by governments to solve the simultaneity problem,⁶⁹⁷ I collect the data of the government direct investment in the forms of government funding and the government guide fund in the domestic VC and PE market. The two factors show the variation of the intermediate activities by the government in VC and PE market, but the Chinese governments play different roles in the process of these two types of investment in the VC and PE market.

Traditionally, the governments in China, behaving as investors, provide government direct

⁶⁹⁶ As our introduction discussed, because both VC and PE are equity investment institutes and has similar functions in the portfolio enterprises, I do not discriminate them in our research, both in analysis and in the data collecting.

⁶⁹⁷ Gilson, "Engineering a Venture Capital Market: Lessons from the American Experience." 1070. See also, White, "Market Failures and Government Failures: Some Cautionary Implications for Financial Reform," 71-74. See also Sibbitt, "Law, Venture Capital, and Entrepreneurism in Japan: A Microeconomic Perspective on the Impact of Law on the Generation and Financing of Venture Businesses," 85. See also Jeng and Wells, "The Determinants of Venture Capital Funding: Evidence across Countries," 278.

investment into enterprises to fund them and guide their behaviors.⁶⁹⁸ Comparatively, the government guide fund is the construction of financial infrastructure.⁶⁹⁹ In this process, the governments act as both an investor of a VC or PE fund and the financial intermediary, such as a VC or PE fund itself. Therefore, the variance of government direct investment and government guide fund can represent how the governments of China have constructed its VC and PE market between 2009 and 2013.

The Technology Innovation Fund for Technical SMEs Annual Report publishes various types of innovation relative fund for SMEs in China. The data of state innovation fund that I record are classified into three categories, including the government guide fund, the fund of state subsidy project and the state technology innovation fund. Continued with the research question in Chapter 2, one of my research goals is to study the relationship between innovative behaviors by the firms and government direct investment, so the data of government direct investment in this study adopts the state technology innovation fund. Besides the state innovation fund in total, the data of the specific amount of innovation fund in the two cities every year are collected separately.

After understanding how the Chinese government designs and structures its financial market, especially its VC and PE market, it is essential to understand how both domestic and foreign investors reflect on the structured VC and PE market. Therefore, I collect the number of the exited VC and PE projects per year and the IPO rate over all exit methods per year. Because the public projects of VC and PE investment are incomplete, I can only rely on these data to

⁶⁹⁸ Keqiang Li (李克强), “Zai Difang Zhineng Zhuanbian He Jigou Gaige Gongzuo Dianshi Dianhua Huiyishang De Jianghua(在地方政府职能转变和机构改革电视电话会议上的讲话)[E-Speech on the Transition of the Functions of Local Governments],” 2013, accessed June 21, 2016, http://www.ce.cn/xwzx/gnsz/szyw/201311/08/t20131108_1724443.shtml.

⁶⁹⁹ For example, the government Anhui province established a Hi-Tech Industry Government Guided Fund funded with 50,00 million Yuan. The government invested 70% of this fund, and other private investors invested the rest 30% of this fund. In the running of this fund, the government selected over 800 projects for the fund to invest. Yan (付艳) Fu, “Zhengfu Touzi Yindao Jijin Touzi Xiangmu Jizhong Qianyue (政府投资引导基金投资项目集中签约)[Aggregated Signed Investment Projects under Government Guide Fund],” *Hefei Zaixian(合肥在线)[Hefei Eve News]*, 2015, http://news.ifeng.com/a/20150605/43915489_0.shtml. See also, Jieying Gui (桂洁英), “Yindao Jijin Yinghou 62 Haowen Xinshidai Gedifang Zhengfu Zhengxian Konghou (引导基金迎后 62 号文新时代, 各地方政府争先恐后)[New Generation of the 62th Document, Many Local Governments Welcome Government Guide Investment Funds],” *Qingke Yanjiu Zhongxin(清科研究中心)[Zero2 IPO Group]*, 2015, accessed June 21, 2016, http://www.p5w.net/fund/gqjj/201503/t20150304_967690.htm.

understand how active the VC and PE funds are in the market through their exit activities, especially IPO, a pivotal exit mechanism for them.⁷⁰⁰

Moreover, recalling the importance of FDI on innovation and economy that I have discussed in the literature review in this chapter, I collect the data of the ratio of foreign VC over all VC and PE in China per year. Also, in the side of finance per se, this factor can tell how the VC and PE market is attractive to the foreign investors, and its variance between 2009 and 2013 can present how the government structures its finance market with the demands of foreign investors on available projects in some extent.⁷⁰¹ On the other hand, the ratio instead of the amount regarding the investments can tell the weights of FDI in the VC and PE market of China, which does not only help to explain the finance market of China but also further help to connect the data of innovation to IP and other economic instruments by the government that discussed in the previous two chapters.

The sources of the above data between 2009 and 2013 are the China Venture Capital Research Institute, China Venture Capital Yearbook and the Technology Innovation Fund for Technical SMEs Annual Report. The dataset of China Venture Capital Research Institute provides the data on the exited VC and PE information. The China Venture Capital Research Institute publishes the data relating to government direct investment and government guide fund. The rest of the data are collected through the latter source.

The China VC Investment Research Institute collects the data published in China Venture Capital Yearbooks. Instead of acquiring the total number in the VC/PE industry in China, in the process of data collection, it does surveys of sampling and the over 800 samples of VC/PE funds in their survey cover all areas in China and all types of industries.⁷⁰² Therefore, its data can represent the status of the development of the VC/PE market in China, but the data also are incomplete. For the incompleteness of the data, the ratios should be more accurate to represent

⁷⁰⁰ Black and Gilson, "Venture Capital and the Structure of Capital Markets: Banks versus Stock Markets."

⁷⁰¹ Recall the potential imbalance of the VC/PE market in developed countries Lu, Tan, and Chen, "Venture Capital and the Law in China." See also, Lerner, Hardyman, and Leamon, *Venture Capital and Private Equity: A Case Book*, 242.

⁷⁰² Zhongguo Fengxian Touzi Yanjiu Yuan(中国风险投资研究院)[China VC Investment Research Institute], *Zhongguo Fengxian Touzi Nianjian 2014*(中国风险投资年鉴 2014)[China Venture Capital Yearbook 2014], 221-222.

the whole data of the VC/PE market in China than the amounts, which is another reason why most of the data that I adopt in this research are ratios rather than amounts.

1.2. Firm-Level Data in Finance

The goal of collecting financial data of the sample firms is to carefully observe the financing activities of their investors and their financial demands and availability of various financing channels. When a firm demands cash, it can issue more shares for investors or lend money from lenders. Therefore, my data collection of the amounts of VC/PE investment, long-term loans and short-term loans can monitor the financing activities of each SME.

The information behind these financing activities can tell the variance of the value of the SMEs during 2009 to 2013 and their financing preferences. By reading the backgrounds of the SMEs, most of the biggest individual investors are entrepreneurs.

Later on, except IPO when the SMEs can acquire public equity investment, for most of the other time when they demand on cash for running their businesses, especially the R&D part, loans, investments from private equity investors or subsequent share offerings in the public market can present their financing preferences. These financial behaviors are clearer and more direct than questionnaires with the managers or even the board members of the SMEs.

Meanwhile, because the process of financing is bilateral, but not just easy to follow the desires of the SMEs, their successful financing activities can reflect how lenders, private investors and public investors value and judge the SMEs and their programs demanding on the cash.

When counting the amount of VC/PE investment and its shareholding ratio within a company, I do not only count those from professional VC/PE funds, but also count the part from some particular types of enterprise investors, such as the enterprises that provide management or legal services to the portfolio companies. This is because these enterprises monitor the portfolio companies and at least provide non-financial support, including management assistance and

access to investors, lenders and other resources, to the portfolio companies, like the functions that are provided by VC investors.⁷⁰³

The shareholding ratio of state-owned enterprise (SOE) investors is collected independently from the shareholding ratio of VC investors. State-owned enterprises behave as angel investors, but they are like government investors and less likely to monitor the running of the businesses by the portfolio firms because of the lack of incentives of monitoring and the knowledge of investing and monitoring.⁷⁰⁴

Under the Chinese stock market that only allows sole class common stock, the percentage of common stock held by different types of investors can show their voting rights which can have an effect on some crucial business decisions, including the direction of doing R&D. Shareholding ratios can more directly present the financing structure of an SME. Therefore, when the data of amount of investment from various types of investors are not available, their shareholding ratios can be their substitutes for some meanings. This can also fix the issue that SMEs may not disclose the exact amount of investment before IPO and the amount of investment from minority investors.⁷⁰⁵

Moreover, after IPOs, that an SME did not have subsequent share offerings for some years does not mean that the structure of the investors of this SME was the same during the years. This is because the exchange of stocks on the public market can result the change of the investors and their shares of the SME, but the transactions of the shares and capital do not flow into the firm. Therefore, the percentage of common stock held by various types of investors can present how these investors were interested in the SMEs and their confidence on the development of the

⁷⁰³ Bottazzi, Da Rin, and Hellmann, "What Is the Role of Legal Systems in Financial Intermediation? Theory and Evidence," 560. Also see, Gulinello, "Engineering a Venture Capital Market and the Effects of Government Control on Private Ordering: Lessons from the Taiwan Experience," 846. Also see, Nahata, "Venture Capital Reputation and Investment Performance," 133. Also see, Barkoczy and Edmundson, "Australasian and South East Asian Venture Capital Tax Expenditure Programs," 59.

⁷⁰⁴ This is because the investments by SOEs are like the Germany venture capital fund, WFG, which is invested by government officers who will not be disciplined for the failure investments. See Gilson, "Engineering a Venture Capital Market: Lessons from the American Experience," 1108. Also see, Ralf Becker and Thomas Hellmann, *The Genesis of Venture Capital-Lessons from the German Experience*, CESifo Working Paper No.883, 2002.

⁷⁰⁵ Usually, these public SMEs only disclose their first ten biggest investors, either individual investors or institutional investors.

SMEs in different stages.

When the entrepreneurs of an SME are also the controllers of the VC funds investing in the SME, however, their investments through this manner are collected in separation from the total value and ratio of VC/PE investment. This is because the monitoring function of these VC funds to the SME could be comparatively more limited than the function of other unrelated VC funds from the financial market.

The difference between institutional investors and VC/PE investors is the time when they enter the investment of the SME. I categorize the organizational investors other than individual investors of the public SMEs as institutional investors. Here, I do not discriminate the channels in which they acquire the stock of the SMEs, either from the public market or the subsequent share offerings other than the public market. By contrast, the organizational investors who enrolled the SMEs before their IPOs are PE/VC investors. Because of their expertise on managing capital for a pool of investors and investing on the equity market, my research do not discriminate their functions and performances in the financial market.

Because the prospectuses disclose the backgrounds of the investors, the data of the amount of VC investment are only from the capital resource of VC investors, excluding the resources of SOE investors or institutional investors. The annual reports only disclose the names of the top ten biggest investors, but not disclose further details of these investors. Some of the institutional investors also invest as VC investors or underwriters,⁷⁰⁶ and it is hard to recognize the function of these investors through their names. Therefore, the shareholding ratio of VC investors inevitable includes parts of some institutional investors, which only takes a small portion of the organizational investors because of the trading restrictions. The restrictions restrain particular types of shareholders or underwriters from trading their shares in general or in a percentage in a particular period of time.⁷⁰⁷

⁷⁰⁶ Zhongguo Zhengjian Hui(中国证监会)[China Securities Regulatory Commission], *Zhengquan Faxing Yu Chengxiao Guanli Banfa*(《证券发行与承销管理办法》)[*Administrative Methods on Stock Issuance and Commitment Underwriting*], Article 9, accessed June 21, 2016, 2013, http://www.csrc.gov.cn/pub/newsite/flb/flfg/bmgz/fxl/201312/t20131224_240253.html.

⁷⁰⁷ Zhongguo Zhengjian Hui(中国证监会)[China Securities Regulatory Commission], *Shangshi Gongsu Guquan Fenzhi*

Some SMEs were invested by VC investors or did not acquire VC investments during 2009 to 2013, but had invested by VC investors. In order to discriminate them from other SMEs that had not acquired any VC investments before 2013, my study uses a dummy variable to indicate the status of the entrance of VC investors into the SMEs. After the VC investors entranced into an SME, the value of the variable is recorded as 1, in contrast to 0.

Moreover, even though the SMEs do not acquire investments from VC investors every year and the variance of percentage of shares held by them may be caused by other types of investors rather than VC investors, once the SMEs have been invested by them, their non-cash contributions can be brought into the SMEs. Therefore, it is vital to discriminate the status of the entrance of SMEs. Similarly, it is also important to discriminate the status of the SMEs before or after the IPO year because IPO brings disclosure requirements on finance and management and the access to lenders, suppliers and customers other than capital alone. Hence, this study controls for the IPO status as a dummy variable.

Monitoring the financing activities by the SMEs, other than private or public equity financing, I also consider on debt financing. Therefore, my data collection includes the amount of long-term loan and the amount of short-term loan that the SMEs obtained. The duration of the repayment of long-term loan is more than one year, and that of short-term loan is less than one year. Even though the SMEs may amortize some amounts of the principal and interest of the loan in the first year of the loan, the lender had authorized them a longer duration than a year. Therefore, for this situation, I still count the debt as long-term loan.

2. General Data Description

Chapter 2 and Chapter 3 describe the data regarding R&D, IP and government funding, and compare the data of the Beijing SMEs to that of the Shanghai SMEs to investigate the behaviors

Gaige Guanli Banfa(上市公司股权分置改革管理办法)[Circular of China Securities Regulatory Commission on Distributing the Measures for the Administration of the Share-Trading Reform of Listed Companies], 2005, Chapter 4 Article 27, accessed June 21, 2016, <http://www.lawinfochina.com/display.aspx?lib=law&id=4552&CGid=>.

of the SMEs among the fourteen industries. Following the comparison between the two cities, this section describes their data regarding financing.

About the resources from the exterior of the firms, the results of t-test show that the amount of long-term loans or short-term loans obtained by the SMEs was not different between the SMEs from the two cities in a statistically significant degree. However, the Beijing SMEs on average acquired slightly more equity financing during 2009 to 2013 than the Shanghai SMEs. The summary statistics in Table 4.1 show that on average, a Beijing SME was funded ¥2.88 RMB from private investors by equity financing. A Shanghai SME yearly obtained ¥1.14 million RMB from private investors through equity investment. In the interior of the firms, the shareholding rates of local and private VCs investing in the Shanghai SMEs on average were slightly higher than those in the Beijing SMEs. The shares of the Shanghai SMEs on average held by local and private VC investors were 2.44 percent higher than those in the Beijing SMEs.

Among all the industries, the industry of information technology, electronic manufacturing, mechanical manufacturing, petroleum and plastic manufacturing, and pharmaceutical manufacturing are the five largest groups of SMEs in the samples. In the industry of information technology, the Beijing SMEs obtained more capital from both government financing and equity financing between 2009 and 2013. In the industry of electronics manufacturing, the Shanghai SMEs were able to acquire more both long-term loans and short-term loans than the Beijing SMEs were.

Moreover, in the industry of mechanical manufacturing, the SMEs from the two cities did not have statistically significant difference in financing activities during 2009 to 2013. In the industry of petroleum and plastic manufacturing, the results of t-tests show that the differences in the amount of equity financing and VC investors' shareholding ratio between the SMEs from Beijing and Shanghai are statistically significant. As regards the results, the Beijing SMEs, which on average obtained more equity financing than the Shanghai SMEs, were controlled by local and private VC investors at a higher level than the Shanghai SMEs were. In addition, in the industry of pharmacy manufacturing, the Shanghai SMEs did not obtain any long-term loans

from banks. In contrast, the Beijing SMEs utilized long-term loans from banks during 2009 to 2013.

With respect to Chapter 2 and Chapter 3, the Beijing SMEs and the Shanghai SMEs performed differently in R&D, IP, financing and marketing between 2009 and 2013, so it is important to investigate the SMEs from the two cities and their IP and financing factors relating to innovation.

3. Methodology

To explore the research questions in Section III, this part utilizes the same panel dataset in Chapter 2 with the above-presented variables and estimates a series of panel data models for them. The panel dataset is constructed for the characteristics of the 82 and 58 enterprises that are registered or headquarter in Zhongguan-Cun Science Park in Beijing and Zhangjiang High-Tech Park in Shanghai. The duration of the data is five years, from 2009 to 2013, and covers at latest three years' data of the public SMEs before the IPO year. Accordingly, the data are coded into five panel datasets for the difference of the two science parks and the difference of the status of IPO.

To explore the association between the equity investment and the debt investment acquired by SMEs, following the theories that the literature review discusses in this chapter, the OLS, random-effects or fixed-effects models are estimated in two-way error component as the followings:

$$\begin{aligned}
 ShortLoan_{ift} = & \alpha + \beta_1 dummyIPO_{it} + \beta_2 dummyVC_{it} + \beta_3 dummySOE_{it} + \beta_4 dummyFDI_{it} \\
 & + \beta_5 dummyGrant_{it} + \beta_6 dummyTaxcredit_{it} + \beta_7 InterestSubsidy_{it} \\
 & + \beta_8 ShortLoan_{ift-1} + \beta_9 PatentIssue_{it} + \beta_{10} UMIssue_{it} + \beta_{11} DesignIssue_{it} \\
 & + \beta_{12} Revenue_{it} + \beta_{13} Employee_{it} + \beta_{14} Industry_f + Year_t + \mu_i + v_{it} \quad (1)
 \end{aligned}$$

$$\begin{aligned}
LongLoan_{ift} = & \\
& \alpha + \beta_1 dummyIPO_{it} + \beta_2 dummyVC_{it} + \beta_3 dummySOE_{it} + \beta_4 dummyFDI_{it} \\
& + \beta_5 dummyGrant_{it} + \beta_6 dummyTaxcredit_{it} + \beta_7 InterestSubsidy_{it} \\
& + \beta_8 PatentIssue_{it} + \beta_9 UMIssue_{it} + \beta_{10} DesignIssue_{it} + \beta_{11} Revenue_{it} \\
& + \beta_{12} Employee_{it} + \beta_{13} Industry_f + Year_t + \mu_i + v_{it} \quad (2)
\end{aligned}$$

where $i \in I_1 = \{1, \dots, 410\}, I_2 = \{1, \dots, 290\}, I_3 = \{1, \dots, 700\}$, $f \in F = \{1, \dots, 14\}$ and $t \in T = \{2009, \dots, 2013\}$.

i denotes the individual SME. t denotes the year in which the SMEs innovate to apply and acquire patents, and f denotes the industry type. $Year_t$, a dummy variable, is controlled as fixed, denoting the time effect and varying across the five years. μ_i is an individual effect and varies across individual SMEs, but not across time. The remainder disturbance, v_{it} , denotes the residual varying with individuals and time. In different individuals or levels of time, α denotes the intercept and $\beta_1, \beta_2, \dots, \beta_{14}$ denote the slopes.

The amount of short-term loans that an SME obtains in a year (*ShortLoan*) and the amount of long-term loans that an SME obtains in a year (*LongLoan*) are chosen as dependent variables to indicate the demand of short-term loans and long-term loans of an SME and its ability to lend capital from banks. The dummy variable, *dummyVC*, controls for the entrance of a real private and local VC, rather than a state-owned enterprise as an investor or a capital pool funded by an SME's own board. If the investors in an SME include state-owned enterprises, the dummy variable, *dummySOE*, controls for the discrimination between this SME from the others. The SMEs invested by foreign direct investment is also distinguished and controlled in the model through the dummy variable, *dummyFDI*. Since the observations are public SMEs, a dummy variable, *dummyIPO*, controls for the stages of an SME's financing, before the IPO and after the IPO. One year-lagged effect of short-term loans also is controlled in the model to indicate the consistent demand of debts among the SME.

Learning from the prior literature, the investment decision of equity investors and debt investors could be relevant to the IPRs that portfolio companies acquired from SIPO. The models add the number of issued utility patents (*PatentIssue*) and issued utility models (*UMIssue*) that

the SME acquires from SIPO in a year as control variables. Meanwhile, the Chinese governments provide subsidies for loan interests to bridge SMEs and lenders. In order to capture this direct government intervention in the financial market, their direct investment that Chapter 2 has discussed, and other indirect intervention, such as through tax credits for SMEs, the models also control for the amount of subsidies for loan interests a year (*InterestSubsidy*), the status of obtaining governments grants or not (*dummyGrant*) and the status of obtaining tax credits in any categories or not (*dummyTaxcredit*) as control variables.

The variables representing individual firm's characteristics and time are also included as other control variables. Revenue of an SME (*Revenue*) indicates a capital resource that the SME has other than financing. The number of employees (*Employee*) surrogates for the size of an SME growing every year. *Industry* is a dummy variable controlling the category of industries where an SME is, so it only varies across individuals, but not across time. The fourteen categories of the industries have been introduced in Chapter 2.

To further explore the association between the equity investment and the debt investment acquired by SMEs, the first two OLS, random-effects or fixed-effects models are improved and estimated in two-way error component as the followings:

$$\begin{aligned}
 ShortLoan_{ift} = & \alpha + \beta_1 VCRatio_{it} + \beta_2 SOERatio_{it} + \beta_3 FDIRatio_{it} + \beta_4 dummyIPO_{it} \\
 & + \beta_5 dummyVC_{it} + \beta_6 dummySOE_{it} + \beta_7 dummyFDI_{it} + \beta_8 InterestSubsidy_{it} \\
 & + \beta_9 ShortLoan_{ift-1} + \beta_{10} IPOFund_{it} + \beta_{11} Cotaxcredit_{it} + \beta_{12} Cataxcredit_{it} \\
 & + \beta_{13} PatentIssue_{it} + \beta_{14} UMIssue_{it} + \beta_{15} DesignIssue_{it} + \beta_{16} Revenue_{it} \\
 & + \beta_{17} Employee_{it} + \beta_{18} Industry_f + Year_t + \mu_i + v_{it} \quad (3)
 \end{aligned}$$

$$\begin{aligned}
 LongLoan_{ift} = & \alpha + \beta_1 VCRatio_{it} + \beta_2 SOERatio_{it} + \beta_3 FDIRatio_{it} + \beta_4 dummyIPO_{it} \\
 & + \beta_5 dummyVC_{it} + \beta_6 dummySOE_{it} + \beta_7 dummyFDI_{it} + \beta_8 InterestSubsidy_{it} \\
 & + \beta_9 IPOFund_{it} + \beta_{10} Cotaxcredit_{it} + \beta_{11} Cataxcredit_{it} + \beta_{12} PatentIssue_{it} \\
 & + \beta_{13} UMIssue_{it} + \beta_{14} DesignIssue_{it} + \beta_{15} Revenue_{it} + \beta_{16} Employee_{it} \\
 & + \beta_{17} Industry_f + Year_t + \mu_i + v_{it} \quad (4)
 \end{aligned}$$

where $i \in I_1 = \{1, \dots, 410\}, I_2 = \{1, \dots, 290\}, I_3 = \{1, \dots, 700\}$, $f \in F = \{1, \dots, 14\}$ and

$t \in T = \{2009, \dots, 2013\}$.

The ratios of the local and private VC investors (*VCRatio*), SOE investors (*SOERatio*) and FDI investors (*FDIRatio*) are controlled as explanatory variables to indicate the effects of the variation of the equity structure in an SME. Moreover, in the two improved models, the status of entitling government grants and tax credits are specified into the amount of IPO fund acquired by an SME (*IPOFund*), the amount of corporate tax credits acquired by the SME (*Cotaxcredit*) and the amount of capital gains tax credits acquired by the SME (*Cataxcredit*) as the control variables.

If the model only focuses on the internal factors impacting on the demands of the short-term loans and long-term loans demanded and obtained by SMEs, following the prior study distinguishing the demand of debt investment among the capital intense firms from the other firms',⁷⁰⁸ the OLS, random-effects or fixed-effects models are estimated in two-way error component as the followings:

$$\begin{aligned} ShortLoan_{ift} = & \\ & \alpha + \beta_1 Netprofit_{it} + \beta_2 InterestSubsidy_{it} + \beta_3 dummyVC_{it} \\ & + \beta_4 dummySOE_{it} + \beta_5 dummyFDI_{it} + \beta_6 dummyGrant_{it} \\ & + \beta_7 dummyTaxcredit_{it} + \beta_8 ShortLoan_{ift-1} + \beta_9 Employee_{it} \\ & + \beta_{10} Industry_f + Year_t + \mu_i + v_{it} \quad (5) \end{aligned}$$

$$\begin{aligned} LongLoan_{ift} = & \\ & \alpha + \beta_1 Netprofit_{it} + \beta_2 InterestSubsidy_{it} + \beta_3 dummyVC_{it} \\ & + \beta_4 dummySOE_{it} + \beta_5 dummyFDI_{it} + \beta_6 dummyGrant_{it} \\ & + \beta_7 dummyTaxcredit_{it} + \beta_8 Employee_{it} + \beta_9 Industry_f + Year_t + \mu_i \\ & + v_{it} \quad (6) \end{aligned}$$

where $i \in I_1 = \{1, \dots, 642\}, I_2 = \{1, \dots, 193\}$, $f \in F = \{1, \dots, 14\}$ and $t \in T = \{2009, \dots, 2013\}$.

The net profit of the SME in a year (*Netprofit*) is selected as an explanatory variable to

⁷⁰⁸ Heitor Almeida and Murillo Campello, "Financing Frictions and the Substitution between Internal and External Funds," *Journal of Financial and Quantitative Analysis* 45, no. 03 (2010): 589–622.

surrogate for the internal financing of the SME. The status of IPO of the SME (*dummyIPO*) is not a control variable anymore in those two models, since the panels of the SMEs before and after IPO are employed under the models separately. Then, their results of coefficients in those two models will be compared by t-test.

To explore the association between the patenting propensity of the SME and its financing, following other studies researching on patenting propensity,⁷⁰⁹ the OLS, random-effects or fixed-effects models are estimated in two-way error component as the followings:⁷¹⁰

$$\begin{aligned} Patent_{ift} = & \alpha + \beta_1 R\&DI_{it} + \beta_2 VC_{Ratio}_{it} + \beta_3 SOE_{Ratio}_{it} + \beta_4 FDI_{Ratio}_{it} + \beta_5 dummyIPO_{it} \\ & + \beta_6 dummyVC_{it} + \beta_7 dummySOE_{it} + \beta_8 dummyFDI_{it} + \beta_9 Indebted_{it} \\ & + \beta_{10} Employee_{it} + \beta_{11} Industry_f + Year_t + \mu_i + v_{it} \quad (7) \end{aligned}$$

$$\begin{aligned} UM_{ift} = & \alpha + \beta_1 R\&DI_{it} + \beta_2 VC_{Ratio}_{it} + \beta_3 SOE_{Ratio}_{it} + \beta_4 FDI_{Ratio}_{it} + \beta_5 dummyIPO_{it} \\ & + \beta_6 dummyVC_{it} + \beta_7 dummySOE_{it} + \beta_8 dummyFDI_{it} + \beta_9 Indebted_{it} \\ & + \beta_{10} Patent_{it} + \beta_{11} Employee_{it} + \beta_{12} Industry_f + Year_t + \mu_i + v_{it} \quad (8) \end{aligned}$$

where $i \in I_1 = \{1, \dots, 410\}$, $I_2 = \{1, \dots, 290\}$, $I_3 = \{1, \dots, 700\}$, $f \in F = \{1, \dots, 14\}$ and $t \in T = \{2009, \dots, 2013\}$.

R&DI is the explanatory variable to signify the R&D intensity of the SME, measured as a ratio of R&D investment to employee numbers, which has been explained in Chapter 2. *Patent* and *UM* are the numbers of utility patent and utility model filings. They are chosen to be dependent variables to capture the patenting propensity of SMEs. The number of patent application filings, *Patent*, is also controlled in model 6 as a control variable for tracking the consistency of patenting behaviors of SMEs. Other than the variables representing the structure of equity investors and their investment status in the SME, the status of either long-term loans or short-term loans (*Indebted*) lent by the SME is controlled as a dummy variable.

To explore the association among revenue, short-term loans and innovation by SMEs,

⁷⁰⁹ Hall and Ham, *The Patent Paradox Revisited: Determinants of Patenting in the US Semiconductor Industry, 1980-94*.

⁷¹⁰ Shown by the regression results, the lagging effects of R&D intensity and R&D investment do not explain the patenting propensity better than their immediate effects, so the model designs finally do not include the lagging effects.

following the model designs in the previous two chapters, the OLS, random-effects or fixed-effects models are estimated in two-way error component as the following:

$$\begin{aligned} Revenue_{ift} = & \alpha + \beta_1 R\&DI_{it} + \beta_2 PatentIssue_{it} + \beta_3 UMIssue_{it} + \beta_4 ShortLoan_{it} \\ & + \beta_5 (R\&DI_{it} * ShortLoan_{it}) + \beta_6 (PatentIssue_{it} * ShortLoan_{it}) \\ & + \beta_7 (UMIssue_{it} * ShortLoan_{it}) + \beta_8 Employee_{it} + \beta_9 Industry_f + Year_t + \mu_i \\ & + v_{it} \quad (9) \end{aligned}$$

where $i \in I_1 = \{1, \dots, 410\}, I_2 = \{1, \dots, 290\}, I_3 = \{1, \dots, 700\}$, $f \in F = \{1, \dots, 14\}$ and $t \in T = \{2009, \dots, 2013\}$.

$R\&DI$, $PatentIssue$ and $UMIssue$ are the control variables and indicate R&D intensity, the number of issued utility patents, issued utility models, and registered software copyrights in an SME in a year.

The two-way interaction terms, $PatentIssue_{it} * ShortLoan_{it}$ and $UMIssue_{it} * ShortLoan_{it}$, capture the interacted effects between short-term loans and the issued utility patents or utility models on the variation of revenue of the SME. In addition, the two-way interaction term, $R\&DI_{it} * ShortLoan_{it}$, captures the covariation between R&D and lending on impacting revenue of the SME.

In addition, to explore the association among revenue, equity investment and innovation by SMEs, following the model designs in the previous two chapters, the OLS, random-effects or fixed-effects models are estimated in two-way error component as the followings:

$$\begin{aligned} Revenue_{ift} = & \alpha + \beta_1 R\&DI_{it} + \beta_2 PatentIssue_{it} + \beta_3 UMIssue_{it} + \beta_4 VCRatio_{it} \\ & + \beta_5 SOERatio_{it} + \beta_6 FDIRatio_{it} + \beta_7 dummyIPO_{it} + \beta_8 dummyVC_{it} \\ & + \beta_9 dummySOE_{it} + \beta_{10} dummyFDI_{it} + \beta_{11} R\&DI_{it} * dummyVC_{it} \\ & + \beta_{12} R\&DI_{it} * dummySOE_{it} + \beta_{13} R\&DI_{it} * dummyFDI_{it} + \beta_{14} Employee_{it} \\ & + \beta_{15} Industry_f + Year_t + \mu_i + v_{it} \quad (10) \end{aligned}$$

$$\begin{aligned}
Revenue_{ift} = & \alpha + \beta_1 R\&DI_{it} + \beta_2 PatentIssue_{it} + \beta_3 UMIssue_{it} + \beta_4 VCRatio_{it} \\
& + \beta_5 SOERatio_{it} + \beta_6 FDIRatio_{it} + \beta_7 dummyIPO_{it} + \beta_8 dummyVC_{it} \\
& + \beta_9 dummySOE_{it} + \beta_{10} dummyFDI_{it} + \beta_{11} PatentIssue_{it} * dummyVC_{it} \\
& + \beta_{12} PatentIssue_{it} * dummySOE_{it} + \beta_{13} PatentIssue_{it} * dummyFDI_{it} \\
& + \beta_{14} Employee_{it} + \beta_{15} Industry_f + Year_t + \mu_i + v_{it} \quad (11)
\end{aligned}$$

$$\begin{aligned}
Revenue_{ift} = & \alpha + \beta_1 R\&DI_{it} + \beta_2 PatentIssue_{it} + \beta_3 UMIssue_{it} + \beta_4 VCRatio_{it} \\
& + \beta_5 SOERatio_{it} + \beta_6 FDIRatio_{it} + \beta_7 dummyIPO_{it} + \beta_8 dummyVC_{it} \\
& + \beta_9 dummySOE_{it} + \beta_{10} dummyFDI_{it} + \beta_{11} UMIssue_{it} * dummyVC_{it} \\
& + \beta_{12} UMIssue_{it} * dummySOE_{it} + \beta_{13} UMIssue_{it} * dummyFDI_{it} \\
& + \beta_{14} Employee_{it} + \beta_{15} Industry_f + Year_t + \mu_i + v_{it} \quad (12)
\end{aligned}$$

where $i \in I_1 = \{1, \dots, 410\}, I_2 = \{1, \dots, 290\}, I_3 = \{1, \dots, 700\}$, $f \in F = \{1, \dots, 14\}$ and $t \in T = \{2009, \dots, 2013\}$.

The interaction terms in the models capture the strength of the associations between issued utility patents or issued utility models and revenue among the SMES invested by various types of investors, including the local and private VCs, the SOE investors and the FDI investors.

V. Results and Implications

Implication 1: Acquiring short-term loan is a consistent strategy for SMEs' financing, and their previous relationship with banks effectively helps them to acquire continuous access of bank financing.

In Table 4.2, among the models to estimate SMEs' demand for short-term loans, the autocorrelation coefficients, which are the coefficients on the one-year lagged short-term loan, are statistically significant and positive, suggesting that the demand and access to short-term loans are consistent with their lending experience in the previous year. After the SMEs have acquired short-term loans, they are more likely to keep acquiring short-term loans from banks.

However, the coefficient in model 8 with the overall samples is 0.63, less than 1, suggesting that they may demand less loans than the previous year.

Even though the model 2, model 5 and model 8 in Table 4.2 do not control for industry categories as fixed for collinearity, the models in Table 4.3 controlling for industry categories as fixed suggest that the one-year lagged short-term loans have positive effect on acquiring short-term loans in the ongoing year. Therefore, the consistency of external financing through short-term loans exists across all industries.

On the other hand, the positive effect of the short-term loans lagged by one year on the acquired short-term loans in the ongoing year could also suggest that the SMEs are easier to access short-term loans after they have successfully acquired short-term loans in a similar and even higher amount from banks in the previous year. In another words, the previous connection of SMEs with banks can effectively help them acquire short-term loans from banks in the ongoing year.

Since Almeida and Campello found a substitution between external financing and internal financing among the financing unconstrained firms,⁷¹¹ in order to further prove the consistent lending behavior of the SMEs, in Table 4.8, the observations are divided as two groups of before and after IPO to estimate the amount of short-term loans and long-term loans. Compared to the SMEs before IPO, the SMEs after IPO can be relatively financing unconstrained and have better financial strategies compared to the private SMEs. For example, they can easily acquire equity financing through subsequent stock offerings.

In the panel of the SMEs after IPO, the coefficients on net profit, representing internal financing of the SMEs, yield statistically significant and negative results, suggesting a negative correlation between their net profit and both short-term loans and long-term loans. A stronger negative correlation of long-term loans and net profit also exists among the private firms, which could be relatively financing constrained compared to the public firms.

Usually, the scholars, such as Lerner and Schoar, argue that the lender protection and

⁷¹¹ Almeida and Campello, "Financing Frictions and the Substitution between Internal and External Funds."

contract enforcement is weak in civil law developing countries, so it is to hardly fill the gap between SMEs and bank lenders for long-term loans.⁷¹² My research result based on SMEs' data is consistent with the common law countries' studies conclusions, such as Almeida and Campello's research, suggesting that long-term loan is a significant substitute of internal financing, especially for private SMEs. When a private SME has lower profitability to provide internal financing and is not as easy as the public SMEs acquiring equity investment by subsequent share offering, they significantly pursue long-term loans, shown by this statistically significant difference in the effects of net profit between the two panels, before and after IPO.

By contrast, the positive and statistically significant coefficient on net profit to predict short-term loans suggests that the correlation between short-term loans and net profit among the private SMEs is positive, which is opposite to the prior literature and the discussed story with respect to long-term loans. This positive correlation suggests that the net profit and short-term loan are supplementary for the private SMEs' financing. On the one side, banks may prefer to the SMEs with relatively higher profitability. On the other side, the private SMEs need external financing supports to supplement their internal financing to expand business, since they have less measures of external financing compared to public SMEs.

Linking this financial decision to their decision to treat long-term loans as substitute of their internal financing, those private SMEs' financial strategies could be inefficient. The cost of short-term loans usually is higher than the cost of long-term loan. However, those SMEs select short-term loans as supplementary financing for their internal financing, but select long-term loans as a substitute. A financial strategy like this could be inefficient, especially when the further implications explain that SMEs adapt to the IP regimes with the significant assistance from either short-term loans or long-term loans. This could be a reason why the SMEs can improve commercialization of R&D and patents through short-term loans rather than long-term loans, regarding the discussion of the regression results in the previous page.

⁷¹² Lerner and Schoar, "Does Legal Enforcement Affect Financial Transactions? The Contractual Channel in Private Equity."

Nevertheless, this is exactly what Giannetti's statistic across countries shows.⁷¹³ Unlisted firms are more likely to be indebted, especially when their local stock market is underdeveloped. The firms from different countries have different debt-preferences, and most of the countries use short-term loans in a higher frequency than long-term loans.

In addition, compared to the SMEs after IPO, whose coefficients on subsidies for either the long-term loan's interest or short-term loan's interest to predict the loans are statistically significant and positive, the SMEs before IPO's coefficients on the subsidies do not yield statistically significant results. In other words, the private SMEs were not significantly subsidized by the government in the process of acquiring debt financing, especially for long-term loans. Therefore, the amount of either long-term or short-term loans did not vary in the same way as the amount of the interest subsidies of the loans did.

By contrast, shown by the statistically significant and positive coefficients on interest subsidy to predict short-term loan and long-term loan with the panel of public SMEs, there is a positive correlation between their interest subsidies and both short-term and long-term loans among public SMEs. In the process of acquiring debt financing, they actively use the interest subsidies. Also, when the regression adds in the one-year lagged short-term loan as an independent variable to predict their short-term loans acquired in the ongoing year, the coefficient yields a statistically significant and positive result. Meanwhile, the statistical significance of the effect of net profit and interest subsidies disappears. The regression result suggests that the demand and access of short-term loans are consistent with their lending experience in the previous year. Since the industry category is controlled as a fixed variable, this consistency of acquiring short-term loan is across all the industries. Nevertheless, this consistency is not clear among the private SMEs, despite an overall consistency existing. Besides the unsolved endogenous issue, one possibility could be that the size of the samples is too small.

It is interesting to see that SMEs are consistently acquiring short-term loans, even after their IPO. Therefore, it is important for the government to explore other measures to fill the gap

⁷¹³ Giannetti, "Do Better Institutions Mitigate Agency Problems? Evidence from Corporate Finance Choices."

between SMEs and long-term loans, rather than just provide ex post loan interest subsidies. This is even more important for the private SMEs, regarding their demands of loans and ineffective financial strategies in the financial market.

Implication 2: Bank loans and public equity investment are substitutes when SMEs demand capital. In addition, innovative SMEs may have other financing forms, such as corporate tax credits, as substitutes of short-term loans for their needs of capital.

The coefficients on the IPO status and the availability on tax credits for SMEs yield statistically significant and negative results, shown by model 7 and model 8 in Table 4.2 with the overall samples to predict short-term loans. Those results suggest that both the group of public SMEs, which have acquired a big amount of capital from public equity market, and the group of SMEs, which can acquire capital gains tax credits, corporate tax credits, or other types of tax credits, on average have less demand for short-term loans in their business running.

In addition, the coefficient on the IPO status to predict long-term loans, shown by model 9 in Table 4.2 with the overall samples, also yields a statistically significant and negative result, suggesting that the public SMEs on average have less demand for long-term loans. In general, public equity investment can be substitutes for SMEs' demand for both short-term loans and long-term loans.

In Table 4.3, shown by the details of the two main types of tax credits for innovation-intensive SMEs, which are corporate tax credits and capital gains tax credits, the coefficients on corporate tax credits yield statistically significant and negative results in model 1, model 4 and model 7 with the three panels of samples. When an SME from any industry acquired more corporate tax credits, this SME would acquire less short-term loans. Some innovative SMEs may demand less capital from bank loans, especially short-term loans. Instead, they can acquire capital from corporate tax credits. On the one hand, the corporate tax credits could be one substitute of short-term loans for the SMEs' demand for capital. On the other hand,

the coefficients on corporate tax credits are over 1, shown by model 1, model 4 and model 7 in Table 4.3, suggesting that every 1 unit increase of corporate tax credits vary with 2.1 units decrease of short-term loans in the overall case. Because the amount of increased corporate tax credits cannot fully offset the decreased amount of short-term loans for the SMEs, they should have other resources of financing as substitutes of short-term loans for their demands for capital.

Implication 3: Lenders care about revenue and IPO status of SME debtors, but may not significantly value the utility patents and utility models owned by the SME debtors.

Regardless of SMEs' demands for capital, the banks may be more likely to lend long-term loans to public SMEs. In Model 9 of Table 4.3, the coefficient on IPO fund yields a statistical significant and positive result, suggesting that the SMEs acquiring more IPO fund acquire more long-term loans from banks.

IPO fund is from local governments to subsidize the high costs of IPO and award to the IPO firms.⁷¹⁴ It is usually payoff in two years before or after the IPO, and the total amount is random.⁷¹⁵ Therefore, when thinking of IPO fund as an indicator of the appreciation by the governments and successful IPO or successfully getting IPO in a big chance, the estimation result in model 8 suggests that the lenders are more likely to lend short-term loans to the SMEs which have successfully gone public and been appreciated by local governments.

In model 1, model 4 and model 7 of Table, presenting the estimations to predict short-term loans for the overall samples, the coefficients on revenue yield statistically significant and positive results, suggesting that revenue has a positive effect on increasing the amount of the

⁷¹⁴ The Beijing Government Office, *Guanyu Jinyibu Tuidong Qiye Shangshi Gongzuo De Yijian*(关于进一步推动企业上市工作的意见)[The Opinions About Further Improving Enterprises' IPOs], 2010. Also see, Yu Sun (孙玉), "Shanghai Minhangqu Shixing Zhongxiao Qiye Shangshi Jiangli Xinzheng(上海闵行区实行中小企业上市奖励新政)[Shanghai Minhang District Employs New Policies to Prize SMEs' IPOs]," *Zhengquan Shibao*(证券时报)[Security Times China], 2008, accessed June 21, 2016, <http://money.163.com/08/0820/10/4PIFICD00251Rj2.html>.

⁷¹⁵ Leaned from the annual reports of the SMEs, the fund can be from the Administrative Committees of Zhongguan-Cun Science Part and Zhangjiang Hi-Tech Park, and local governments of the headquarters of the SMEs. There was no clear standards for regulating the IPO fund, and it usually depends on how the governments appreciate the development and future of an SME, their ongoing beneficial policies, and probably their relationship with the SME.

short-term loans acquired by SMEs. On the one side, for the SMEs with better market performance, represented by their increased revenue, they may demand more external financing in their business running and they think of short-term loans from banks as a significant form of external financing. On the other side, when banks make decisions on lending SMEs, whose business is riskier than bigger firms, especially the innovation-intensive SMEs, revenue is a significant factor to be considered by banks.

Banks, nevertheless, may not think of the utility patents and utility models owned by SMEs as a significant factor when approving loans to them. In the estimations to predict short-term loans and long-term loans, the coefficients on issued utility patents do not reach a statistically significant degree. Even the issued utility patents in the previous year cannot show correlation with the amount of short-term loans and long-term loans in a statistically significant degree. Therefore, the estimation results suggest that issued utility patents of SMEs have insignificant effects on the amount of short-term loan acquired by the SMEs.

While the coefficients on utility models yield statistically significant and positive results when predicting short-term loans with the overall panel's samples and the Beijing panel's samples, I cannot infer the results that bank lenders value the utility models owned by the SME debtors. Instead, those bank lenders may not significantly value utility models. Without a process of substantive examination, the value and quality of a technology protected under utility models should be lower than a technology in a form of utility patents. Therefore, when utility patents cannot have a significant effect on acquiring more loans from banks for SMEs, utility models also should not have a significant effect. There must be another endogenous factor with the characteristics of acquiring more short-term loans and issued utility models.

Implication 4: SMEs are adapting to the IP regime under the supports from debt financing. With short-term or long-term bank loans, they apply for more utility patent applications and utility model applications. Despite that no obvious evidence shows that SMEs effectively invest the acquired loans in their R&D, short-term loans can effectively support them improving the

efficiency of commercialization of R&D, utility patents and utility models in their business running.

In Table 4.4, among the product-term estimations to predict revenue, the base group for *indebted* is the group of SMEs not acquiring any short-term loans and long-term loans in the ongoing year. In the overall case, the SMEs acquiring either short-term loans or long-term loans from banks are estimated to apply for 2.62 utility patents and 0.93 utility models more than the SMEs not acquiring any bank loans, with the same levels of R&D intensity and other equity financing status. In other words, the SMEs with the supports from debt financing on average have higher propensity to file utility patent and utility model applications.

Nevertheless, SMEs may not invest the bank loans in their R&D activities, which are a pre-condition of applying for patents. Both the amount of short-term loans and long-term loans acquired by SMEs are less likely to correlate with their R&D investment ($r=0.05$ with the overall panel's data). The insignificant correlation between bank loans and R&D investment cannot suggest that SMEs are effectively using the bank loans to conduct R&D.

In order to explore the reason why the indebted SMEs have higher propensity to file utility patents and utility models when the bank loans do not significantly contribute to their capital needs for conducting R&D, the models in Table 4.5 add product-term between short-term loans and other variables representing innovation, including R&D intensity, issued utility patents and issued utility models. The added product terms account roughly for 5% of the variance of revenue.

Even though the coefficient on R&D intensity shows a statistically significant result in the main-effect only model with the overall data, shown by model 5, the statistical significance disappears after the interaction term between R&D intensity and short-term loans are added in model 6. However, the coefficient on the interaction term yields a statistically significant and positive result. It suggests that the R&D intensity could have a positive effect on revenue through its interaction with the moderator variable, short-term loans. In other words, innovation-intensive

SMEs can effectively acquire more revenue with the short-term loans that they lent from banks.

In model 6 of Table 4.5, the coefficient on issued utility patents yields a statistically significant and negative result to predict revenue. However, the interaction term between issued utility patents and short-term loans is estimated as positive in a statistically significant degree when the estimation holds years and industry categories as fixed, suggesting a positive effect of short-term loans on increasing a positive contribution of issued utility patents to improving revenue. For every ¥10,000 RMB that short-term loan increases, the slope of revenue on issued utility patents increases 0.1 units.

The estimated result suggests that when a SME acquires more than ¥42,728,200 RMB, its issued utility patents shall have a positive effect on improving its revenue. Actually, most of the SMEs did not acquire that much of short-term loans. However, it does not mean that SMEs should increase their leverage ratio. Even though the mean of short-term loans acquired by the SMEs is higher than this threshold (mean of overall case=54,621,630, mean of Beijing's case=53,483,217, mean of Shanghai's case=56,258,361), the distribution of short-term loans is positive skew. There could be other endogenous factors inside the mechanism, allowing the SMEs to acquire more short-term loans compared to other SMEs and transform their issued utility patents effectively to revenue. At least, short-term loans have a significant effect on supporting this effective IP commercialization mechanism.

While the coefficient on the interaction term between short-term loans and issued utility models yields a statistically significant and negative result in model 6, its value is lower than the value of the positive estimated coefficient on the interaction term between short-term loans and issued utility patents. Only if the acquired short-term loans are higher than ¥98,019,802 RMB, will the effect of issued utility models on improving revenue turn from positive to negative. Actually, less than 15% of the SMEs acquired short-term loans over this threshold. If they all did, the effect of issued utility patents should be positive to offset the negative effect of issued utility models on improving revenue. This could be a fair result of the patent strategy of an SME to commercialize their R&D and IPRs.

Overall, SMEs could effectively improve their R&D commercialization and commercialization of utility patents and utility models with the increased amount of short-term loans that they acquired from banks. Meanwhile, under the effect of bank loans, they apply for more utility patents and utility models. For all industries across the years from 2009 to 2013, the SMEs were adapting to the IP regime under the supports from debt financing.

Implication 5: Despite revenue of the SMEs invested by SOE investors is higher than the other SMEs, SOE investors cannot effectively assist SMEs to improve the commercialization of their R&D, utility patents and utility models, compared to local and private VCs.

In model 3 of Table 4.5, the coefficient on SOEs' share ratio yields a statistically significant and positive result to predict revenue. This result suggests that the SMEs involving more SOE investors could acquire more revenue in general. I am interested in if the higher revenue comes from a higher efficiency of commercialization of R&D and IPs after the SMEs have consulted with SOE investors. In other words, I am interested in whether the regression coefficient is different from the corresponding regression coefficient for the SMEs without the involvement of SOE investors when regressing revenue onto R&D intensity, issued utility patents and issued utility models together for SOE-invested SMEs.

Therefore, the models in Table 4.7 control for those factors' interaction with the involvement of SOE investors and present two slopes of revenue on R&D intensity with issued utility patents or issued utility models being identical or different, respectively. For the overall case, shown by model 7, model 8 and model 9, the coefficients for the interaction terms in the three models were statistically significant, suggesting the presence of interactions. However, the coefficients yield negative results, suggesting that SOE investors exacerbate the impact of R&D intensity, issued utility patents and issued utility models on improving revenue.

In model 7, when R&D intensity, issued utility patents, issued utility models, SOEs' share ratio, VC and institutional investors' share ratio, and FDIs' share ratio, year, size and industry

categories are held as fixed, for every 1 unit of R&D intensity of a non-SOE and non-VC invested SME increases, revenue is predicted to increase by ¥10,720,000 RMB. By contrast, for every 1 unit of R&D intensity of a SOE invested SME increases, revenue is predicted to decrease by ¥9,460,000 RMB, if the SME has not been invested by a local and private VC. If the SOE-invested SME also has been invested by a local and private VC, the effect of R&D intensity on improving revenue is positive because the coefficient on the interaction term between R&D intensity and local and private VC involvement yields a statistically significant and positive result. Nevertheless, the effect is still lower than the effect among the SMEs without the involvement of SOE investors.

If we look into the two cities' samples, shown by model 1 and model 4, for the group of Beijing and Shanghai SMEs, coefficients on R&D intensity of the SOE invested SMEs also yield statistically significant and negative results, even though the coefficients on R&D intensity of all the SMEs in the two cities yield statistically significant and positive results. It is consistent that in the two cities, SOE investors cannot effectively assist SMEs to transform their R&D outcomes to revenue and even exacerbate the commercialization of R&D by the SMEs.

In the case of utilizing IPs, shown by model 8 and model 9, the coefficients on issued utility patents and issued utility models by the SOE-invested SMEs yield statistically significant and negative results. I could formally explain the results that the two types of patents in the SOE-invested SMEs not only cannot help the SMEs to grab more revenue from the market, but also the patents may impede their business running more serious than the SMEs without the involvement of SOE investors.

On the other hand, because the coefficients on the issued utility patents and issued utility models are insignificant, I turn to treat those two count variables as moderator variables. For every one more utility patent that an SOE-invested SME acquires in a year, its revenue is predicted to decrease by ¥22,040,000 RMB in that year, when the estimation holds R&D intensity, issued utility patents, issued utility models, SOEs' share ratio, VC and institutional investors' share ratio, FDIs' share ratio year, size and industry categories as fixed. After an

SOE-invested SMEs acquires eight more utility patents in a year, its revenue is predicted to be lower than the SMEs without any investments and any contributions from SOE investors.

The efficiency of management of utility models in the SOE-invested SMEs is in a similar situation as their utility patent management, but the negative effect from this moderator variable is less than the negative effect of utility patents on improving revenue. For every one more utility patent that an SOE-invested SME acquires, its revenue is predicted to decrease by ¥5,457,000 RMB. The threshold of having lower revenue than the SMEs without any contributions from SOE investors is going up to fourteen utility models, in a higher degree than utility patents.

By contrast, the coefficient on the issued utility patents to predict revenue is statistically significant and positive in the case of Beijing, and the coefficient on the issued utility models to predict revenue is statistically significant and positive in the overall case, shown by model 2 and model 9 of Table 4.7. In the overall case, the SMEs invested by local and private SMEs on average can acquire more revenue when they are acquiring more utility models. In other models, the coefficients on the two patent factors do not yield statistically significant results, suggesting that the utility patents acquired by the local and private-VC invested SMEs are insignificant to impede or improve their revenue.

Overall, the SOE-invested SMEs on average cannot effectively improve their revenue with their R&D activities and patents that they acquire. Especially for the SMEs involving SOE investors only, but no local and private VCs, conducting R&D and acquiring utility patents and utility models interfere with the growth of their revenue. In other words, SOE investors cannot effectively assist them to improve their commercialization of R&D, utility patents and utility models, compared to other types of investors, such as local and private VCs. While acquiring either the two types of the patents could impede their business running, it seems that the obstruction from utility models is weaker than the obstruction from utility patents. When the SOE-invested SMEs do not have strong capabilities on IP management, the cost of utility models for them is always lower than the cost of utility patents, even after the process of patent application.

Some of the SOEs investing in SMEs are business banks, incubators and VCs. For example, China Gaoxin Investment Group Corp. (CGI), investing in Beijing Lanxum Technology Co., Ltd. and Beijing Century Real Technology Co., Ltd., two of my samples in the group of Beijing, is a state-owned investment mechanism to act as a VC/PE investor for technical SMEs and an institutional investor in stock market, and also interests in merger and acquisition. CGI is a subsidiary of State Development & Investment Corp. (SDIC), established by the P.R.C. State Council in 1995 and under the administration of the central government.⁷¹⁶ SDI invests in various industries, including the traditional industries, the high-tech industries and the financial industries under the central government's policies and encourage sub-investments in some industries through their subsidiaries in the form of investment group, such as CGI. CGI usually invests in the pharmaceutical and bio-engineering industries, the new material and resources industries, the industries of new energy and energy conservation and the industries of manufacturing.

Alternatively, some SOEs only invest in the SMEs that are in the same industry with them. Many of the sample SMEs invested by SOEs belong to this situation. For example, Sinosteel Corporation funds a special subsidiary, Sinosteel Corporation Investment, to make investment in the steel businesses. Mysteel.com, one of my samples in the group of Shanghai, is invested by Sinosteel Corporation Investment.

For either open financial services or narrowed investments in an industry, the fund managers have special expertise in the area that they invest in. However, SOEs' business models could be different from other private companies. Their monopoly market position and close relationships with governments could provide the invested SMEs better access of market even without IPs.⁷¹⁷ Other than providing better access of the market, another benefit of having SOE investment could be that they can directly apply the central government's policies to the SMEs in the industries so as to decrease some transaction costs in the process of realizing the country's

⁷¹⁶ State Development & Investment Corp., "Guanyu Guotou(关于国投)[About SDIC]," accessed March 15, 2016, http://www.sdic.com.cn/cn/gygt/gsj/A010101index_1.htm.

⁷¹⁷ Peijun Duan and Tony Saich, *Reforming China's Monopolies*, 2014, accessed June 21, 2016, http://ash.harvard.edu/files/reforming_chinas_monopolies.pdf.

mission, compared to the local governments' subsidies and grants to encourage the development of the industries. Therefore, it is fair to see that in China, the SOE-invested SMEs on average have a higher degree of revenue than the SMEs not invested by SOE investors.

Similar to private venture capitalists, SOE investors care about the revenue of the invested SMEs, and the fund managers are liable for making bad investment decisions because State-owned Assets Supervision and Administration Commission of the Chinese State Council (SASAC) monitors their performances.⁷¹⁸ However, the moral hazard issue could still be more serious in the investments made by SOE investors who are managing state assets rather than the capital from private investors.⁷¹⁹

On the other hand, even though SOEs do have incentives to encourage SMEs to conduct R&D because they need to effectively apply the central governments' policies encouraging innovation, the policies do not require that they should induce SMEs to effectively commercialize their R&D outcomes. Meanwhile, different from the subsidies or the grants from government, which usually request for IPs as a pre-condition, they may not require SMEs to acquire more IPRs so that they may take the valuable IPRs back when the invested SMEs are bankrupt. For the SOEs practicing in the industries, they may be too traditional to be good at IP strategies, so they could not provide appropriate advice to the invested SMEs to effectively commercialize their utility patents and utility models.

Implication 6: Local and private VCs could monitor and assist SMEs to transform utility patents and utility models to revenue, compared to the other SMEs not invested by the VCs, but the effectiveness of the monitor and assistance is limited. The overall revenue of the SMEs invested by the VCs shows that their market performance is worse than the other SMEs and bank loans are complementary for the SMEs to improve their patenting propensity. However, the SMEs invested by the VCs in average have stronger capabilities of R&D commercialization than the

⁷¹⁸ State Development & Investment Corp., "SDIC Introduction," accessed March 20, 2016, accessed June 21, 2016, http://www.sdic.com.cn/en/about/sidcint/A020101index_1.htm.

⁷¹⁹ Guoguang Wu and Helen Lansdowne, eds., *China's Transition From Communism-New Perspectives*, 2016.

other SMEs.

Among the 642 observations for the 136 SMEs across five years, 160 observations are invested by SOE investors, (taking 21.18% of the total observations), and 70.62% of them, 113 observations, are invested by local and private VCs simultaneously.

In total, 385 observations are invested by local and private VCs, and t-test for their revenue and the revenue of the group of SMEs not invested by the VCs does not yield a statistical significant result. However, when model 3 in Table 4.6 to predict revenue holds R&D intensity, issued utility patents, issued utility models, SOEs' share ratio, VC and institutional investors' share ratio, FDIs' share ratio year, size and industry categories as fixed, the coefficient on the dummy variable of local and private VC-invested group of SMEs yields a statistically significant and negative result, suggesting that those VC invested SMEs on average acquire less revenue than the other SMEs across various industries. Since the coefficient on the dummy variable of the SMEs invested by local and private VCs is insignificant in model 2 with the group of Shanghai's samples, the difference between local and private VC-invested SMEs and other SMEs' revenue is insignificant among the Shanghai SMEs.

One possibility is that local and private VCs cannot provide effective non-cash contributions, such as access to market or other resources, other than the capital that the SMEs need. In Table 4.7, even though model 7 and model 9 with overall data suggests that VC and institutional investors' share ratio has a positive effect on improving revenue in a statistically significant degree, without an exogenous factor to control for the choice of institutional investors, it is hard to defend for the effectiveness of the non-cash contributions from local and private VCs because more institutional investors may enter the SMEs when its market performance is comparatively better than others.

Another possibility is that local and private VCs invest in many SMEs in an immature stage of their development. Therefore, the average revenue of the local and private VC-invested SMEs is naturally lower than the other SMEs.

In order to explore how local and private VCs advice SMEs to improve their efficiency in commercializing R&D and IPs, the models in Table 4.7 control the two-way interaction terms between the involvement of local and private VCs and R&D intensity, issued utility patents or issued utility models. The coefficients on the local and private VC-invested SMEs' R&D intensity and issued utility models, shown by model 7 and model 9 in Table 4.7, yield statistically significant and positive results, while the coefficients on the group of the local and private VC-invested SMEs yield statistically significant and negative results. Those estimation results suggest that when the local and private VC-invested SMEs have higher R&D intensity or acquire more utility models, the difference between their revenue and the revenue of the other SMEs not invested by local and private VCs in a negative degree can be moderated.

When the R&D intensity of a local and private VC-invested SME increases by 18.14 units, it can reach the average revenue level of the SMEs not invested by the VCs. Alternatively, it can reach the average revenue level of those SMEs if it acquires roughly 20 more utility models in year.

Unfortunately, these two thresholds are too high to be achieved by the SMEs. In the overall sample, over 97% of the observations can only acquire less than 19 utility models in total per year, and increasing utility models' issuance may not be prolonged. Similarly, over 97% of the observations cannot reach the threshold of R&D intensity. Therefore, to moderate the negative effect of local and private VCs' involvement on revenue, improving the number of issued utility models could be unrealistic. Overall, learning from the above analysis, I infer that local and private VCs may be able to monitor and assist SMEs to transform IPs to revenue, compared to the other SMEs, but the effectiveness of their monitor and assistance is limited.

By contrast, improving R&D intensity could be an effective measure to improve the local and private VC-invested SMEs' revenue. In model 1, model 4 and model 7 of Table 4.7, the coefficients on R&D intensity yield statistically significant and positive results, suggesting that innovation-intensive SMEs can acquire on average more revenue. Also, when the SMEs improve their R&D intensity, the estimations predict that they can acquire more revenue. Taking the

effect of the involvement of local and private VCs into account, when an SME increases one unit of R&D intensity, its revenue can increase ¥20.21 million RMB. The extent of the growth is almost one time more than the effect of R&D intensity on improving revenue of the SMEs not invested by local and private VCs. Therefore, it seems that the SMEs invested by local and private VCs on average have stronger capabilities of R&D commercialization.

The capital of local and private VCs may not just come from private funds, but also is a pool involving government guide funds and funds from various levels of governments. Even though those VCs are not state-owned, they are tightly controlled by SOEs or governments. For example, Shenzhen Innovation Capital Investment Co., Ltd, investing in China Net Center, Beijing TRS Information Technology and Beijing Easpring Material Technology, is a private VC and makes investments with the capital from its parent company, which is Shenzhen Capital Group Co. LTD. (SCG).⁷²⁰ SCG is a state-owned VC and under the monitor of Shenzhen SASAC.⁷²¹

The fund managers in a VC like Innovation Capital Investment are not directly monitored by SASAC, which is the representative of the real investor of the funds, and they do not have the liabilities of working for the government as the SOEs' employees. On the other hand, the pool has stable investments from their parent company, which is an SOE and also has stable investments from government. In a situation like this, the moral hazard issue could be more serious in investments made by it, compared to SOE investors. There are also other forms of cooperation with governments and investments with state assets. For example, there are local and private VCs like Zijiang Holdings starting cooperating with local governments and universities to manage their own funds and funds from the cooperators as incubators after their successful investment in Shanghai WellTech Automation, one of the sample SMEs.⁷²² In the case of Shanghai WellTech Automation, Zijiang Holdings invested its own money and monitor the

⁷²⁰ "Shenzhen Capital Group Co., Ltd," accessed March 20, 2016, <http://www.szvc.com.cn>.

⁷²¹ State-Owned Assets Supervision and Administration Commission of the People's Government of Shenzhen Municipality, "Shenzhen Shi Chuangxin Touzi Jiquan Youxian Gongsi(深圳市创新投资集团有限公司)[Shenzhen Innovation Investment Group Co., Ltd.]," accessed March 20, 2016, http://www.szgzw.gov.cn/szgq/qygk/qyfc_7/.

⁷²² "Chanye Buju(产业布局)[Layout of Industries]," accessed March 20, 2016, http://www.zijiang.com/indus_park.asp.

investment by its own team, so the moral hazard could be smaller.

Moreover, Winfast Holding, investing in Beijing BDStar Navigation, Ruitai Technology, Beijing Orient Landscape, Sanju Environmental Protection, Beijing Fuxing Xiaocheng Electronic Technology, GI Technologies, and Orient Landscape, only Beijing public SMEs, used to only make institutional investments, but transformed its business to make PE investments in some companies in a mature stage of their development.⁷²³ As a professional investment institution, it may have better view of selection of invested objects than governments or SOEs. Therefore, it is not surprising that the innovation-intensive SMEs invested by the local and private VCs like Winfast Holding could have a higher efficiency in commercializing R&D.

Besides PE/VC investment, a main business of Winfast Holding is hedge fund,⁷²⁴ so there should be moral hazard existing in their businesses. However, regardless of moral hazard issues in a VC/PE like Winfast Holding, Zhongguan-Cun is still encouraging any forms of VCs, which invests in equities and may involve other types of investments as well.

In 2011, there were 544 VC investments in Zhongguan-Cun, in amount of ¥35.5 billion RMB, which were taken roughly one-third of the whole cases of VC investment in China.⁷²⁵ The Administration Office of Zhongguan-Cun provides guide fund and corporates with local and private VCs to encourage the VCs to invest, or subsidizes 10% for their investment in the technical companies founded less than five years. However, the government does not request the quality of investment or monitor of R&D and IP activities in the invested companies for the subsidies.

While the coefficient on the issued utility patents acquired by Beijing SMEs invested by local and private VCs yields a statistically significant and positive result, shown by model 2 in

⁷²³ Wei Li (李巍), “Ruihua Touzi Zhang Jianbin: Yige Gushi Gaoshou De Huali Zhuanshen(瑞华投资张建斌: 一个故事高手的华丽转身)[Ruihua Investment Zhang Jianbin: A Gorgeous Turn Around by A Master in the Stock Market],” *China Stock Paper*, August 26, 2013, accessed June 21, 2016, <http://finance.sina.com.cn/money/smjj/20130826/025016556905.shtml>.

⁷²⁴ “Winfast Holding,” accessed March 20, 2016, <http://www.jiangsuruihua.com/dcjj.php>.

⁷²⁵ Fuli Song (宋馥李), “Baogao: Zhongguan Cun Chuangtou Jigou 100 Duoqia, Guanli Zijin Chao 200 Yi Meiyuan(报告: 中关村创投机构 100 多家, 管理资金超 200 亿美元)[Report: There Are More Than 100 VC Institutions in Zhongguan-Cun, Managing Capital over \$0.2 Billion],” *Jingji Guancha Wang(经济观察网)[Economic Observation Web]*, 2012, accessed June 21, 2016, <http://www.eeo.com.cn/2012/0316/222793.shtml>.

Table 4.7, in order to acquire higher revenue than the average revenue of the other SMEs not invested by the VCs, the estimation suggests that an SMEs should acquire at least 7 utility patents in a year. This threshold is too high to be met by over 95% of the Beijing SMEs. Therefore, based on the estimation result, it is hardly to conclude that the local and private VCs can effectively monitor and assist the Beijing SMEs to improve their utility patents' commercialization.

Meanwhile, in the models to predict propensity on utility patents, shown by Table 4.3, the coefficients of the involvement of local and private VCs are not statistically significant, suggesting that the SMEs invested by local and private VCs on average do not file more utility patents than the other SMEs in a statistically significant degree. Despite the coefficient on utility models in model 6 to predict the propensity of SMEs with the overall data yields statistically significant and positive result, the estimation result may not be explained as that the local and private VC-invested SMEs on average file more utility model applications and the other SMEs.

In model 6, the coefficient on filed utility patent applications yields a statistically significant and positive result, suggesting that the propensity on utility models and on utility patents should be consistent. However, the consistency of the significance of the effect of the involvement of local and private VC-invested VCs on improving the filings of the two types of patents by the SMEs is not shown in those estimation results.

There could be another possibility. Local and private VCs may realize that SMEs do not have enough capabilities on managing patents, especially utility patents. Both the application cost and maintenance cost of utility patents are higher than utility models. Therefore, they may induce their invested SMEs to file more utility models rather than utility patents. However, this explanation would be very weak because the statistical significance is in the 90% degree ($p\text{-value} < 0.1$), which is a weak significance. Meanwhile, in model 6, the coefficient on VC and institutional investors' share ratio yields a statistically significant and negative result, suggesting that when there are more VCs and institutional investors controlling an SME, the SME files less utility model applications. It seems that VCs value utility models, but may not effectively induce

them to file more utility model applications.

Compared to the effect of local and private VCs on the propensity of SMEs on utility patents and utility models, the coefficients on the group of SMEs acquiring either long-term loans or short-term loans yield statistically significant and positive results, shown by model 5 and model 6. Those estimated results suggest that in order to improve the propensity of local and private VC-invested SMEs either on utility patents or on utility models, bank loans are supplementary with equity financing for them.

Moreover, it seems that if SMEs lack patenting propensity or the ability of patent commercialization, local and private VCs do not effectively assist them to improve those. However, the local and private VC-invested SMEs in average do have stronger capabilities of R&D commercialization. In order to improve their commercialization of IP, the governments may add some pre-conditions for acquiring government guide funds and the subsidies. Then, the government/SOE-cooperated funds and subsidized funds could be motivated to improve their knowledge and skills on patent and patent commercialization.

VI. Conclusion

China is establishing its financial market through state-owned banks and encouraging the development of a “multi-layer capital market system.”⁷²⁶ As the empirical evidence shows, in practice, long-term loans and short-term loans, rather than private equity or venture capital investment, are actively used by SMEs in the process of improving their revenue and net profit with utility patents. Other than loan interests, it is important for the government to fill the gap between SMEs and long-term loans.

In the Chinese financial market, this empirical study shows that the association of the patenting propensity of the SMEs with bank loans is stronger than its association with private

⁷²⁶ Lu, Tan, and Chen, “Venture Capital and the Law in China,” 254.

equity financing. Among various types of venture capital investors, the SMEs invested by SOE investors on average generate revenue in a higher degree than the other SMEs. Those SMEs' excellent market performance suggests that the SOEs still play a pivotal role in the development of the economy in China. Therefore, when the Chinese government is promoting "mass entrepreneurship and innovation," this point should not be disregarded. However, in those SOE-invested SMEs, my empirical evidence also shows that the association between R&D intensity and revenue is negative.

Compared to the relatively stronger immediate R&D commercialization capabilities by the SMEs invested by the local and private VCs, the equity investment contains much direct government investment, which brings inevitable moral hazard issues in the VC market. The further studies can explore how those moral hazard issues could be relieved to bolster the development of the VC market in China. It is also valuable to survey around the SMEs to understand the internal mechanisms by which FDI investors, SOE investors and local and private VCs induce patenting and patent commercialization by the portfolio SMEs.

VII. Tables

Table 4.1. Summary Statistics by Three Panels: Firm Characteristics, Financing Information, Govt. Supports, IPRs

Variable	Shanghai SMEs					Beijing SMEs					Overall SMEs				
	Mean	Std. Dev.	Min	Max		Mean	Std. Dev.	Min	Max		Mean	Std. Dev.	Min	Max	
R&D Intensity (R&D/Employee)	4.104	3.716	0	398.49		5.709	4.265	0	454.10		5.05	4.12	0	454.10	
Revenue	540.34	421.24	38.77	1969.85		483.76	377.32	30.64	1962.38		506.90	396.53	30.64	1969.85	
Net Profit	63.68	174.45	-1752.33	982.26		94.58	163.16	-496.78	2548.78		81.97	168.41	-1752.33	2548.78	
Employee	791.27	658.39	23.00	3627.00		809.42	899.01	34.00	7640.00		801.98	808.56	23.00	7640.00	
VCRatio	12.92	19.63	0	88.89		10.41	9.59	0	47.22		11.40	14.62	0	88.89	
SOERatio	3.97	13.23	0	82.31		7.00	15.55	0	82.82		5.76	14.71	0	82.82	
FDIRatio	13.07	25.17	0	100.00		1.00	5.99	0	100.00		5.93	17.73	0	100.00	
Long-Term Loan	7.60	42.65	0	634.43		10.40	48.68	0	720.00		9.25	46.30	0	720.00	
Short-Term Loan	56.26	149.54	0	1492.17		53.48	132.69	0	1106.18		54.62	139.74	0	1492.17	
Loan Interest Subsidy	0.16	0.63	0	5.00		0.25	0.74	0	6.25		0.21	0.70	0	6.25	
IPO Fund	0.25	0.62	0	3.7		0.29	0.60	0	3.00		0.27	0.61	0	3.7	
Capital Gains Tax Credits	1.07	3.90	0	27.43		5.66	13.36	0	162.31		3.79	10.81	0	162.31	
Corporate Tax Credits	7.38	8.20	0	72.12		8.11	10.40	0	88.93		7.88	9.55	0	88.93	
#Utility Patent Application Filings	3.06	5.55	0	47.00		6.08	16.51	0	194.00		4.84	13.25	0	194.00	
#Issued Utility Patents	0.61	1.51	0	9.00		1.23	5.08	0	70.00		0.97	4.03	0	70.00	
#Utility Model Application Filings	3.10	6.89	0	73.00		2.74	7.46	0	78.00		2.89	7.23	0	78.00	
#Issued Utility Model	2.97	7.01	0	77.00		2.28	7.10	0	100.00		2.56	7.07	0	100.00	
#Design Patent Application Filings	1.48	6.83	0	68.00		0.81	3.04	0	36.00		1.08	4.96	0	68.00	
#Issued Design Patents	1.45	7.57	0	102.00		0.72	3.14	0	42.00		1.02	5.41	0	102.00	
#Software Copyright	2.22	8.62	0	89.00		3.67	6.94	0	40.00		3.08	7.70	0	89.00	

Note: The unit of the measure of capital amount is ¥1,000,000 RMB.

Table 4.2. Models to Estimate the Access of and Demands for Short/Long-Term Loans

Panels	Beijing			Shanghai			Overall		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Predictors	STL	STL	LTl	STL	STL	LTl	STL	STL	LTl
	RE	FE	RE	RE	RE	RE	RE	FE	RE
#Issued Utility	-110.7 (102.8)	-37.88 (105.2)	-9.401 (50.81)	-180.3 (507.8)	263.8 (237.1)	84.99 (190.1)	-55.05 (101.4)	17.37 (86.79)	13.72 (47.00)
#Issued Utility Model	136.2* (76.46)	-21.43 (81.38)	-10.37 (36.77)	133.3 (119.7)	-25.43 (52.19)	78.64** (39.18)	153.6** (62.86)	-4.972 (57.26)	20.14 (28.03)
Loan Interest Subsidy	11.43 (7.051)	-1.882 (6.184)	5.601 (3.519)	41.07*** (12.08)	-1.687 (5.681)	14.96*** (4.152)	16.25*** (5.838)	-3.668 (4.577)	8.369*** (2.726)
1. dummy_IPO	-2,910** (1,439)	-2,428* (1,418)	-1,703** (728.1)	-2,632 (2,015)	-2,240** (1,044)	-314.6 (704.7)	-2,784** (1,131)	-2,442** (1,011)	-1,179** (523.5)
1. dummy_SOE	1,449 (1,988)	7,814*** (2,887)	335.2 (649.5)	-1,861 (2,321)	-981.8 (956.3)	-1,106* (641.2)	651.2 (1,545)	1,625 (1,533)	-189.5 (486.2)
1. dummy_VC	843.5 (1,799)	- (574.6)	238.0 (574.6)	2,605 (2,612)	218.6 (958.1)	687.0 (567.3)	1,037 (1,622)	- (444.6)	520.9 (444.6)
1. dummy_FDI	-3,741 (2,699)	14,692*** (4,300)	20.29 (984.4)	-3,266 (2,655)	129.4 (952.3)	-555.9 (591.1)	-1,890 (1,895)	2,926 (2,375)	-759.0 (561.5)
STL_1		0.729*** (0.0776)			0.906*** (0.0299)			0.630*** (0.0582)	
Revenue	0.120*** (0.0221)	0.112*** (0.0246)	-0.00436 (0.00951)	0.0539 (0.0329)	0.0415*** (0.0128)	0.0161* (0.00844)	0.0966*** (0.0182)	0.103*** (0.0181)	0.00695 (0.00675)
1. dummy_Grant	-2,949 (2,002)	-2,052 (1,945)	158.3 (993.6)	8,943* (5,194)	770.6 (2,490)	990.8 (1,739)	-1,387 (1,837)	-2,186 (1,593)	145.2 (848.0)
1. dummy_Tax Credit	-8,708*** (3,084)	-10,458*** (2,929)	341.6 (1,469)	-1,858 (3,266)	-1,243 (1,269)	-938.2 (871.1)	-5,774*** (2,042)	-5,376*** (1,662)	33.62 (901.8)
Constant	11,736** (5,649)	7,020* (3,708)	60.39 (2,080)	-9,454 (11,264)	901.2 (2,899)	-413.2 (1,973)	6,994 (6,087)	4,662* (2,593)	-16.75 (1,686)
Observations	378	300	380	263	208	263	641	508	643
Number of stock	80	80	80	55	55	55	135	135	135
Tech Fe	Yes	No	Yes	Yes	No	No	Yes	No	Yes
Size	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.2805	0.543	0.0231	0.0972	0.2682	0.1112	0.1749	0.441	0.0271

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 4.3. Models to Estimate Access of and Demands for Short/Long-Term Loans with Detailed Government Supports

Panels	Beijing			Shanghai			Overall		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Predictors	STL	STL	LTL	STL	STL	LTL	STL	STL	LTL
	FE	RE	RE	FE	RE	RE	FE	RE	RE
IPO Fund	-7.082 (7.925)	-9.832 (8.006)	12.56*** (4.285)	-2.361 (8.960)	-5.891 (5.542)	-0.587 (4.345)	-4.311 (5.924)	-7.890 (5.000)	8.258*** (3.013)
Corporate Tax Credits	-1.551** (0.627)	-0.575 (0.493)	-0.108 (0.284)	-3.911*** (1.180)	-0.468 (0.622)	-1.324*** (0.472)	-2.103*** (0.556)	-0.742* (0.382)	-0.281 (0.235)
Catpital Gains Tax Credits	-1.391** (0.647)	-0.435 (0.353)	0.0304 (0.224)	1.922 (2.885)	-0.457 (1.230)	-0.0799 (0.913)	-0.774 (0.632)	-0.248 (0.320)	-0.0420 (0.206)
Loan Interest Subsidy	3.456 (7.210)	-2.986 (5.797)	5.141 (3.484)	20.86** (10.20)	-1.172 (5.760)	16.09*** (4.388)	11.43* (5.906)	1.046 (4.196)	8.485*** (2.710)
VC Ratio	28.96 (70.97)	7.955 (56.06)	12.70 (31.07)	-255.0** (117.5)	-42.03 (34.96)	0.881 (23.22)	-19.69 (59.11)	11.78 (29.78)	8.119 (17.32)
SOE Ratio	-50.29 (133.7)	-0.922 (50.56)	44.16 (28.58)	-36.01 (204.9)	-5.043 (49.80)	13.81 (31.33)	-43.34 (113.4)	9.991 (34.81)	24.38 (19.96)
FDI Ratio	125.5 (122.8)	-203.2 (216.6)	-6.855 (47.61)	111.5 (135.4)	34.16 (34.34)	0.346 (22.65)	65.25 (83.43)	-19.69 (32.69)	4.059 (18.01)
1. dummy_VC	92.87 (3,242)	602.3 (1,050)	172.0 (644.9)	-1,370 (4,460)	109.7 (1,232)	594.2 (778.1)	-406.0 (2,628)	415.3 (821.5)	474.8 (481.0)
1. dummy_IPO	-2,909* (1,501)	-772.5 (1,329)	-1,740** (728.2)	-3,606* (1,961)	-2,082* (1,130)	-91.50 (789.0)	-3,214*** (1,195)	-1,528* (917.5)	-1,349** (532.0)
1. dummy_SOE	4,944 (3,320)	-840.9 (1,557)	-807.3 (961.3)	-342.8 (2,476)	-1,264 (1,171)	-1,189 (870.5)	1,797 (1,995)	-445.2 (1,034)	-660.7 (644.7)
1. dummy_FDI	649.5 (3,555)	1,804 (2,438)	-123.7 (1,176)	-4,031 (3,624)	-662.3 (1,623)	-754.8 (1,149)	-1,278 (2,572)	-109.4 (1,300)	-958.3 (782.2)
Revenue	0.172*** (0.0274)	0.0583*** (0.0175)	-0.00283 (0.0101)	0.0327 (0.0364)	0.0494*** (0.0155)	0.0255** (0.0110)	0.118*** (0.0220)	0.0588*** (0.0120)	0.0110 (0.00719)
STL_1		1.179*** (0.0557)			0.883*** (0.0317)			0.997*** (0.0312)	
Constant	-1,906 (2,415)	-1.042 (1,377)	-1.042 (1,377)	11,751*** (4,009)	-1,442 (3,286)	-1,178 (2,149)	1,272 (2,087)	1,431 (2,254)	-76.48 (1,289)
Observations	378	300	380	262	207	262	640	507	642
Number of stock	80	80	80	55	55	55	135	135	135
Tech Fe	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.284	0.4563	0.0534	0.186	0.2692	0.1384	0.180	0.3958	0.0388

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 4.4. Models to Estimate Patenting Propensity

Panels	Beijing		Shanghai		Overall	
	(1)	(2)	(3)	(4)	(5)	(6)
Predictors	Utility	UM	Utility	UM	Utility	UM
	RE	RE	FE	RE	RE	RE
R&D Intensity	1.164*** (0.237)	-0.196*** (0.0754)	-0.0628 (0.123)	-0.180* (0.109)	0.835*** (0.150)	-0.178*** (0.0626)
VC Ratio	0.0293 (0.100)	-0.0709** (0.0315)	0.0374 (0.0613)	-0.0209 (0.0373)	0.0338 (0.0535)	-0.0510** (0.0227)
SOE Ratio	-0.127 (0.113)	-0.0259 (0.0335)	-0.143 (0.112)	-0.00455 (0.0511)	-0.0520 (0.0654)	-0.0185 (0.0281)
FDI Ratio	0.107 (0.151)	-0.0273 (0.0474)	-0.0907 (0.0723)	-0.0427 (0.0348)	-0.0259 (0.0557)	-0.0200 (0.0232)
1. dummy_VC	3.310 (2.732)	0.356 (0.796)	1.148 (2.371)	1.380 (1.301)	2.543 (1.648)	1.201* (0.729)
1. dummy_FDI	-4.867 (4.252)	1.525 (1.294)	6.745*** (1.954)	2.838* (1.523)	-2.533 (2.333)	2.690*** (0.973)
1. dummy_SOE	5.474 (3.705)	1.554 (1.119)	0.511 (1.320)	0.125 (1.141)	1.732 (1.940)	0.342 (0.822)
1. dummy_IPO	2.344 (2.339)	1.328* (0.745)	-0.296 (1.054)	-0.507 (0.929)	1.379 (1.407)	0.461 (0.577)
1. Indebted	4.830*** (1.858)	2.279*** -0.586 (0.0167)	-0.881 (0.771)	-0.0113 (0.698)	2.617** (1.098)	0.930** (0.455)
#Utility Patent		0.320*** (0.0167)		0.587*** (0.0636)		0.336*** (0.0167)
Constant	-13.42** (6.764)	1.907 (1.933)	-1.184 (2.284)	0.581 (1.410)	-9.086* (4.964)	0.638 (0.804)
Observations	379	379	263	263	642	642
Number of stock	80	80	56	56	136	136
Tech Fe	Yes	Yes	No	No	Yes	No
Size	Yes	Yes	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.1016	0.5297	0.148	0.3223	0.0635	0.4362

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 4.5. Estimate Revenue with Short-Term Loans' Main Effect and Product Terms

Panels	Beijing		Shanghai		Overall	
	(1)	(2)	(3)	(4)	(5)	(6)
	RE	RE	RE	RE	RE	RE
R&D Intensity (R&D/Employee)	1,064*** (365.2)	908.9** (388.8)	325.5 (444.3)	-605.4 (414.4)	812.2*** (284.1)	400.1 (290.4)
#Issued Utility Patents	-258.2 (227.6)	-368.0 (243.1)	2,365*** (857.8)	503.0 (830.8)	-165.3 (215.7)	-440.1** (218.1)
#Issued Utility Model	225.5 (175.0)	249.9 (248.8)	-293.4 (213.6)	-94.51 (191.8)	136.3 (135.9)	297.0** (146.5)
STL (Short-Term Loan)	0.645*** (0.115)	0.450** (0.206)	0.139 (0.125)	-0.593* (0.334)	0.455*** (0.0845)	0.271* (0.147)
R&D Intensity×STL		0.0147 (0.0212)		0.301*** (0.0690)		0.0516*** (0.0189)
#Issued Utility Patents×STL		0.0563* (0.0324)		0.0150 (0.0705)		0.103*** (0.0253)
#Issued UM×STL		-0.00635 (0.0184)		-0.0215 (0.0168)		-0.0303*** (0.00926)
Constant	-2,215 (12,561)	-687.0 (12,769)	16,721 (25,707)	17,461 (23,338)	479.7 (13,106)	3,514 (13,268)
Observations	377	377	264	264	641	641
Number of stock	80	80	56	56	136	136
Tech Fe	Yes	Yes	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.5628	0.5703	0.4655	0.5989	0.5020	0.5454
Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.						

Table 4.6. Main-Effect-Only Models to Predict Revenue

Panels	Beijing	Shanghai	Overall
Predictors	(1)	(2)	(3)
	RE	RE	RE
R&D Intensity	644.9* (381.1)	320.4 (446.6)	648.7** (287.2)
#Issued Utility Patents	-302.2 (239.6)	2,333*** (841.8)	-150.0 (217.4)
#Issued Utility Model	426.9** (184.1)	-193.1 (216.3)	282.8** (137.6)
VC Ratio	332.9** (153.9)	191.7 (183.7)	169.4 (109.4)
SOE Ratio	556.9*** (188.8)	388.1 (287.1)	351.9** (148.3)
FDI Ratio	422.6* (236.7)	-99.38 (176.1)	239.5** (119.5)
1. dummy_VC	-12,409** (4,840)	-7,407 (6,647)	-13,453*** (3,809)
1. dummy_FDI	-3,773 (6,641)	-8,583 (6,845)	-10,107** (4,711)
1. dummy_SOE	907.7 (6,140)	6,616 (4,711)	5,037 (3,826)
1. dummy_IPO	-207.1 (3,393)	-750.7 (3,657)	61.28 (2,479)
Constant	15,279*** (5,044)	16,721 (29,137)	11,506 (12,981)
Observations	379	263	642
Number of stock	80	56	136
Tech Fe	No	Yes	Yes
Size	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes
R-square	0.5422	0.4920	0.5002

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 4.7. Product-Term Models to Predict Revenue

Panels	Beijing			Shanghai			Overall		
Predictors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	RE	RE	RE	RE	RE	RE	RE	RE	RE
R&D Intensity	891.2* (532.2)	644.7* (376.6)	916.9** (388.6)	3,572*** (1,046)	119.5 (450.3)	459.5 (464.4)	1,072** (428.3)	592.6** (284.6)	770.5*** (293.6)
#Issued Utility Patents	-331.8 (233.6)	-692.7 (762.8)	-324.2 (240.1)	1,695** (833.9)	5,363*** (1,384)	2,490*** (856.3)	-182.6 (214.8)	565.8 (648.2)	-166.5 (219.8)
#Issued UM	736.6*** (202.5)	362.9** (183.8)	532.4 (583.0)	-69.55 (212.9)	-92.13 (219.5)	-896.0 (706.7)	355.9** (141.7)	220.7 (136.8)	-51.27 (444.2)
VC Ratio	356.5** (151.0)	345.0** (154.4)	390.9** (156.3)	199.0 (178.6)	148.6 (178.6)	205.2 (183.5)	188.3* (108.8)	161.1 (109.6)	190.1* (110.2)
SOE Ratio	430.0** (190.3)	450.0** (190.4)	519.2*** (189.5)	302.4 (279.0)	342.9 (271.9)	380.8 (285.2)	309.4** (148.9)	277.5* (149.2)	314.8** (148.8)
FDI Ratio	459.2** (233.7)	409.5* (235.2)	470.7** (235.2)	-176.5 (170.6)	-174.3 (170.4)	-86.02 (176.5)	213.5* (120.0)	217.1* (120.9)	227.0* (120.1)
1. dummy_VC	-17,857*** (6,674)	-13,759*** (4,910)	-14,241*** (4,998)	-13,810* (7,720)	-6,179 (6,388)	-8,398 (6,842)	-19,034*** (4,884)	-13,806*** (3,844)	-15,310*** (3,911)
1. dummy_FDI	-9,081 (8,633)	-3,222 (7,142)	-8,680 (7,140)	5,763 (7,994)	-4,020 (7,009)	-11,369 (7,304)	-6,084 (5,702)	-8,330* (4,962)	-9,551* (5,021)
1. dummy_SOE	23,748*** (8,291)	6,261 (6,288)	2,816 (6,260)	12,390** (5,943)	7,042 (4,912)	8,601* (5,075)	15,397*** (4,998)	8,561** (3,874)	7,124* (3,969)
1. dummy_IPO	-763.3 (3,306)	-713.2 (3,343)	-616.1 (3,343)	-713.0 (3,556)	465.2 (3,676)	-618.4 (3,685)	-248.6 (2,447)	-652.7 (2,446)	45.99 (2,477)
R&D Intensity × #Issued Utility	-3,534*** (926.7)			-1,508* (805.2)			-2,018*** (609.2)		
		-2,100*** (645.9)			-2,020 (2,120)			-2,204*** (554.0)	
#Issued UM×dummy_SOE			-980.2** (454.0)			-612.6 (566.5)			-545.7* (313.2)
R&D Intensity × dummy_VC	681.0 (753.5)			1,705* (898.1)			1,049* (560.5)		
#Issued Utility Patents×dummy_VC		2,211** (957.2)			-2,819 (1,747)			1,046 (810.3)	
#Issued UM×dummy_VC			599.1 (648.7)			651.1 (665.1)			779.2* (438.0)
R&D Intensity × dummy_FDI	1,047 (1,023)			-4,207*** (1,095)			-750.2 (575.5)		
#Issued Utility Patents×dummy_FDI		-927.3 (793.9)			-3,517** (1,788)			-986.9 (681.3)	
#Issued UM×dummy_FDI			1,562* (908.3)			262.5 (398.4)			-301.4 (317.7)
Constant	14,196*** (5,427)	15,820*** (5,037)	14,161*** (5,089)	18,840 (27,543)	17,114 (25,981)	16,599 (28,474)	9,606 (13,203)	11,391 (13,112)	10,335 (12,924)
Observations	379	379	379	263	263	263	642	642	642
Number of stock	80	80	80	56	56	56	136	136	136
Tech Fe	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.5719	0.5626	0.5593	0.5326	0.5120	0.5001	0.5178	0.5190	0.5046

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 4.8. The Access and Demands of Bank Loans Before and After IPO

Independent Variables							
Dependent Variables Patenting Propensity	Short-Term Loan_1	Net Profit	Interest Subsidy	Tech Fe	R-sq	Obs.	Model Types
1. Short-Term Loans							
After IPO (A)		-0.150*** (0.0306)	15.04** (6.532)	No	0.1557	448	FE
Before IPO (B)		0.507*** (0.138)	-2.770 (6.515)	Yes	0.2601	192	RE
P-value of Difference (A)-(B)		[0.044]	[0.198]				OLS
2. Short-Term Loans							
After IPO (A)	1.065*** (0.0362)	0.0325 (0.0231)	1.213 (4.766)	Yes	0.3564	417	RE
Before IPO (B)	-0.317 (0.218)	0.636 (0.475)	-12.96 (12.45)	No	0.405	90	FE
P-value of Difference (A)-(B)	[0.765]	[0.740]	[0.743]				OLS
2. Long-Term Loans							
After IPO (A)		-0.0687*** (0.00904)	7.479*** (2.189)	Yes	0.0331	448	RE
Before IPO (B)		-0.371** (0.164)	-13.33 (12.06)	Yes	0.0667	194	RE
P-value of Difference (A)-(B)		[0.083]	[0.087]				

Note: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The models also controls for firm size, VC investment fixed, SOE Investment fixed, FDI fixed, tax credit entitlement fixed, government grant entitlement fixed. The model type is selected by Hausman test.

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Appendix

Table A.1. Main-Effect-Only Models & Product-Term Models to Predict Revenue

Panels	Beijing				Shanghai		Overall	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Model Types	RE	RE	RE	RE	RE	FE	FE	FE
R&D Intensity	1,052*** (358.6)	827.9** (367.1)	1,135*** (361.2)	911.8** (370.2)	394.1 (475.6)	515.0 (497.5)	885.8*** (295.6)	802.8*** (298.8)
#Issued Utility Patents	-340.3 (221.0)	-254.5 (225.1)	-329.3 (220.5)	-245.4 (224.7)	1,378 (1,195)	1,927 (1,195)	-399.0* (220.2)	-300.4 (226.6)
#Issued Utility Model		462.5*** (173.5)		456.2*** (173.2)		-139.5 (238.5)		243.8* (141.7)
#Software		49.64 (225.8)		46.46 (225.3)		244.6 (324.5)		175.9 (193.1)
Fund	-0.469 (0.406)	-0.398 (0.406)	-0.438 (0.406)	-0.369 (0.405)	5.574*** (1.815)	4.126** (1.854)	-0.457 (0.400)	-0.424 (0.400)
Prize	8.444 (8.135)	7.646 (8.144)	25.99* (13.28)	24.36* (13.31)	-5.945 (8.858)	-3.972 (9.098)	5.354 (5.884)	5.149 (5.879)
Catpital Gains Tax Credits	3.693*** (1.240)	3.980*** (1.241)	3.821*** (1.240)	4.096*** (1.240)	-2.850 (5.272)	0.565 (5.910)	4.378*** (1.285)	4.576*** (1.290)
R&D Intensity× Prize			-2.640* (1.582)	-2.515 (1.584)				
Constant	336.9 (12,849)	1,906 (12,462)	-318.7 (12,810)	1,262 (12,419)	5,195 (27,701)	17,583*** (5,020)	15,283*** (2,427)	15,583*** (2,431)
Observations	353	353	353	353	240	240	593	593
Number of stock	75	75	75	75	53	53	128	128
Tech Fe	Yes	Yes	Yes	Yes	Yes	No	No	No
Issued Patents Fe	No	No	No	No	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.5527	0.5574	0.5715	0.5764	0.4680	0.477	0.516	0.519

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Regardless of the effects of corporate tax credits, all the samples in these models are entitled to corporate tax credits.

Table A.2. Main-Effect-Only Models & Product-Term Models to Predict Net Profit

Panels	Beijing				Shanghai		Overall			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Model Types	RE	RE	RE	RE	RE	RE	RE	RE	RE	RE
R&D Intensity	284.0 (239.6)	384.4 (233.9)	-332.8 (248.2)	-244.7 (246.6)	970.5*** (361.8)	915.8** (363.2)	418.2** (203.6)	485.3** (204.2)	-49.23 (212.6)	23.13 (214.2)
#Issued Utility Patents	-311.3* (174.9)	-345.3** (173.4)	-305.3* (165.9)	-333.3** (165.2)	-251.2 (1,027)	-126.5 (1,021)	-244.1 (172.4)	-277.5 (172.2)	-239.3 (167.1)	-268.5 (167.3)
#Issued Utility Model		-343.8*** (122.3)		-277.7** (117.0)		-227.7 (176.8)		-312.4*** (101.7)		-264.5*** (99.37)
#Software		-228.7* (135.4)		-198.6 (129.0)		93.27 (171.1)		-19.41 (112.4)		-3.515 (110.3)
Fund	0.559** (0.282)	0.443 (0.282)	-4.857*** (0.919)	-4.754*** (0.913)	-1.175 (1.474)	-1.103 (1.470)	0.578** (0.289)	0.537* (0.288)	-4.295*** (0.870)	-4.152*** (0.867)
Prize	-2.644 (6.387)	-2.145 (6.326)	-4.575 (6.075)	-3.940 (6.036)	14.79** (7.085)	15.76** (7.091)	3.894 (4.607)	4.652 (4.587)	4.339 (4.467)	4.967 (4.455)
Catpital Gains Tax Credits	3.959*** (0.765)	3.585*** (0.752)	3.491*** (0.724)	3.174*** (0.719)	2.048 (3.565)	2.292 (3.590)	3.897*** (0.804)	3.804*** (0.801)	3.446*** (0.790)	3.376*** (0.788)
1.Dummy Issued Patents	2,592 (2,327)	3,961* (2,350)	1,867 (2,210)	3,022 (2,244)	60.39 (4,005)	173.7 (4,028)	1,427 (1,850)	2,595 (1,878)	832.2 (1,795)	1,830 (1,828)
R&D Intensity× Fund			0.730*** (0.119)	0.702*** (0.118)					0.658*** (0.111)	0.634*** (0.111)
Constant	3,099 (5,127)	1,872 (2,322)	8,304* (4,871)	5,896** (2,313)	3,098 (13,480)	3,006 (13,632)	3,418 (5,981)	3,081 (5,966)	6,967 (5,959)	6,519 (5,960)
Observations	353	353	353	353	239	239	592	592	592	592
Number of stock	75	75	75	75	53	53	128	128	128	128
Tech Fe	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.0808	0.0860	0.1626	0.1659	0.0467	0.0610	0.0467	0.0579	0.1084	0.1165

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Regardless of the effects of corporate tax credits, all the samples in these models are entitled to corporate tax credits.

Table A.3. Patenting Propensity

Panels	Beijing			Shanghai			Overall		
	Patent (1)	LM (2)	Copyright (3)	Patent (4)	LM (5)	Copyright (6)	Patent (7)	LM (8)	Copyright (9)
Predictors	FE	RE	RE	RE	FE	RE	RE	RE	RE
Model Types									
R&D Intensity	0.740** (0.296)	0.0201 (0.116)	0.0692 (0.0879)	0.160 (0.117)	-0.141 (0.143)	0.0208 (0.115)	0.602*** (0.155)	0.00555 (0.0865)	0.0731 (0.0691)
Fund	-3.55e-05 (0.000321)	1.90e-05 (0.000130)	-4.87e-05 (9.94e-05)	0.000417 (0.000454)	0.000629 (0.000525)	-7.16e-06 (0.000425)	-4.72e-05 (0.000216)	3.76e-05 (0.000120)	-5.25e-05 (9.49e-05)
Prize	-0.000123 (0.00615)	-0.00209 (0.00274)	-0.00170 (0.00199)	0.00367* (0.00222)	-0.000175 (0.00261)	-0.000744 (0.00211)	0.00152 (0.00345)	-0.000427 (0.00187)	-0.00108 (0.00143)
Capital Gains Tax	0.00491*** (0.00104)	0.000373 (0.000375)	0.000363 (0.000304)	-0.000752 (0.00121)	-9.30e-05 (0.00169)	0.000137 (0.00130)	0.00369*** (0.000609)	0.000393 (0.000347)	0.000260 (0.000291)
Patent Subsidy	0.243*** (0.105)	0.168*** (0.0433)		0.0243 (0.0304)	-0.0350 (0.0350)		0.200*** (0.0506)	0.0622** (0.0278)	
Constant	-3.715 (2.430)	1.649 (2.919)	3.381 (3.193)	0.124 (4.996)	-1.831 (1.407)	-0.428 (8.800)	-4.777 (4.609)	1.834 (2.885)	2.872 (3.462)
Observations	353	353	353	240	240	240	593	593	593
Number of stock	75	75	75	53	53	53	128	128	128
Tech Fe	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Regardless of the effects of corporate tax credits,

Table A.4. Patenting Propensity

Panels Predictors	Beijing					Shanghai					Overall				
	Patent FE	Patent FE	UM FE	Copyright RE		Patent FE	UM FE	Copyright FE			Patent FE	Patent FE	UM FE	Copyright FE	
R&D	0.00264*** (0.000539)	0.00290*** (0.000546)	0.000715*** (0.000253)	0.000345** (0.000167)		0.000751* (0.000293)	0.000161 (0.000434)	0.000588* (0.000346)			0.00230*** (0.000384)	0.00257*** (0.000389)	0.000562*** (0.000178)	0.000192 (0.000155)	
R&D ^c	-6.22e-08*** (1.33e-08)	-8.09e-08*** (1.55e-08)	-1.66e-08*** (6.26e-09)	-9.20e-09*** (4.19e-09)		-1.87e-08* (9.96e-09)	-4.73e-09 (1.10e-08)	-1.34e-08 (8.86e-09)			-5.24e-08*** (9.59e-09)	-6.63e-08*** (1.04e-08)	-1.37e-08*** (4.63e-09)	-4.85e-09 (3.86e-09)	
Fund	-7.41e-05 (0.000311)	-6.15e-05 (0.000308)	1.93e-05 (0.000146)	-5.70e-05 (0.000100)		0.000204 (0.000481)	0.000577 (0.000531)	-0.000102 (0.000445)			-0.000106 (0.000244)	-0.000101 (0.000241)	-2.76e-06 (0.000120)	-6.79e-06 (9.87e-05)	
Prize	0.00212 (0.00599)	0.00234 (0.00594)	-0.00160 (0.00281)	-0.00137 (0.00201)		0.00475** (0.00238)	2.95e-05 (0.00262)	-0.000689 (0.00219)			0.00328 (0.00360)	0.00370 (0.00357)	-5.71e-05 (0.00187)	-0.000708 (0.00146)	
Capital Gains Tax Credits	0.00472*** (0.00109)	-0.000655 (0.00257)	0.000391 (0.000513)	0.000471 (0.000325)		-0.00116 (0.00154)	-7.17e-05 (0.00170)	-0.000219 (0.00132)			0.00425*** (0.000811)	-0.000712 (0.00173)	0.000243 (0.000363)	0.000176 (0.000327)	
Patent Subsidy	0.332*** (0.106)	0.267** (0.109)	0.140*** (0.0496)			0.0316 (0.0320)	-0.0348 (0.0353)				0.179*** (0.0547)	0.140** (0.0555)	0.0676** (0.0278)		
R&D Intensity X Capital Gains															
Constant	-3.264* (1.882)	-1.798 (1.972)	-0.454 (0.883)	1.372 (0.883)		-1.678 (1.176)	-2.521* (1.298)	-0.341 (7.378)			-2.468* (1.261)	-1.535 (1.282)	1.397 (2.788)	0.127 (0.508)	
Observations	353	353	353	353		240	240	240			593	593	593	593	
Number of stock	75	75	75	75		53	53	53			128	128	128	128	
Tech Fe	No	No	No	No		Yes	No	No			No	No	No	No	
Size	Yes	Yes	Yes	Yes		Yes	Yes	Yes			Yes	Yes	Yes	Yes	
Year Fe	Yes	Yes	Yes	Yes		Yes	Yes	Yes			Yes	Yes	Yes	Yes	
R-square	0.209	0.225	0.107	0.1507		0.128	0.131	0.1154			0.178	0.197	0.0697	0.135	

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Regardless of the effects of corporate tax credits, all the samples in these models are entitled to corporate tax credits.

Table A.5. Patenting Propensity

Panels	Beijing		Shanghai			Overall		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Predictors	Utility	UM	Design	UM	Design	Utility	UM	Design
	RE	RE	RE	RE	FE	RE	RE	FE
R&D	0.00254*** (0.000437)	-0.000186 (0.000147)	-7.77e-05 (6.13e-05)	-0.000141 (0.000305)	-0.000343 (0.000417)	0.00212*** (0.000305)	-0.000178 (0.000133)	-2.20e-05 (0.000133)
R&D ²	-4.36e-08** (1.16e-08)	3.76e-10 (3.85e-09)	9.55e-10 (1.62e-09)	3.11e-09 (7.95e-09)	7.44e-09 (1.07e-08)	-3.96e-08*** (8.12e-09)	1.40e-09 (3.47e-09)	8.22e-10 (3.31e-09)
#Utility Patent Application Filings		0.328*** (0.0172)	0.134*** (0.00726)	0.601*** (0.0630)	-0.0805 (0.0816)		0.342*** (0.0169)	0.110*** (0.0155)
#Court	-0.112 (0.388)	0.145 (0.131)	-0.0465 (0.0564)	0.106 (0.148)	-0.0993 (0.178)	0.0124 (0.237)	0.137 (0.0990)	-0.0872 (0.0822)
Appeal Rate	-34.78 (31.78)	-20.53* (10.74)	-6.607 (4.634)	-7.509 (12.57)	13.77 (15.08)	-28.68 (19.67)	-16.86** (8.252)	2.642 (6.860)
#Total Utility Patent Application Filings	-2.92e-06 (5.61e-05)	-2.23e-05 (1.89e-05)	4.59e-06 (8.17e-06)	-1.65e-05 (2.15e-05)	1.15e-05 (2.57e-05)	-1.48e-05 (3.43e-05)	-2.10e-05 (1.44e-05)	1.01e-05 (1.19e-05)
Constant	17.58 (19.33)	0.851 (6.430)	4.116 (2.750)	-1.099 (7.124)	-1.825 (8.567)	7.819 (12.11)	-0.312 (4.874)	2.818 (3.934)
Observations	379	379	379	264	264	643	643	643
Number of stock	80	80	80	56	56	136	136	136
Tech Fe	Yes	Yes	Yes	No	No	Yes	Yes	No
Size	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Grant Fe	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Tax Credit Fe	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
R-square	0.1331	0.5030	0.4605	0.3093	0.086	0.1048	0.4150	0.127

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.